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PROFITABLE AND FRUITLESS LINES OF ENDEAVOR IN PUBLIC HEALTH WORK[1]

IT is in accord with the spirit of this Congress to consider public health questions either from the point of view of things already accomplished by the application of the scientific method or from that of things to be done. I have chosen to speak especially of "the saving of waste and increase of efficiency" still to be expected when public health problems are approached in a scientific spirit.

It is well recognized to-day by many experts that while some of the ordinary activities of municipal health departments are of unquestionable value in conserving the health of a community, others are relatively ineffective or possibly worthless. One well-known writer[2] has thus expressed himself on this point:

> I boldly assert that if every case of communicable disease were promptly reported to the proper local board of health and as promptly placed under effective sanitary control and so kept until danger of infection had passed, all the other present-day activities of boards of health, whether local, state or national, with the exception of those directed against certain causes of infant mortality, and the possible further exception of some food and drug inspection, might be dropped with no appreciable effect upon the general health or mortality of any of our states or most of our cities.

In all fairness it must be admitted that a part of the energy of almost every municipal health department in this country

[1] Paper presented before the Congress of Technology, Boston, April 10, 1911, to commemorate the fiftieth anniversary of the granting of the charter to the Massachusetts Institute of Technology.

[2] M. N. Baker, chairman Committee on Municipal Health and Sanitation, National Municipal League.

is devoted to combating imaginary dangers or applied to tasks that have only a remote bearing on the public health.

This condition, as a rule, is not due to ignorance on the part of health officials, but to the pressure of public opinion. Such pressure is often exerted directly through legal ordinances passed by uninformed legislative bodies, but sometimes also through agitation by mistaken enthusiasts or through other channels of public opinion. Back of the whole situation is the existence in the public mind of wrong or antiquated conceptions of disease and the causes of disease. It was unfortunate in many respects for the cause of public health that much of the popular interest in health matters was evoked before the germ theory of disease and its corollaries became fully developed. As the result of premature generalization the public has warmly espoused a number of wrong conceptions of disease and of ways of preventing disease. To be specific, two instances of this confusion are found in the demand for garbage disposal and plumbing inspection.

Sanitarians do not admit that even a grossly improper method of garbage disposal can have much to do with the spread of disease in a sewered city or that diphtheria or typhoid fever or any other disease is properly attributable to the entrance of sewer air into dwelling houses. So firmly embedded in public belief, however, is the connection of piles of decaying garbage with outbreaks of infectious disease, and of "defective plumbing" with all sorts of maladies that to the average citizen "garbage disposal" and "plumbing inspection" bulk large as the chief if not the only activities of a municipal health department.

In the light of our present knowledge we may well ask what are the actual dangers to health from these two sources? It is now well known to bacteriologists that disease germs do not "breed" in garbage heaps, but that on the contrary if added from outside they speedily die off. The offensive odors of decomposition may be unpleasant and undesirable; there is no evidence that they produce disease or dispose to disease. On the other hand, it may be argued that the existence of heaps of decomposing organic matter tends to maintain or create general habits of uncleanliness which themselves are detrimental in a roundabout way to the health of a community. And again it is known that the house-fly may breed in garbage piles, particularly if horse manure is present, and that under certain conditions this noxious insect may become the bearer of disease germs to food. But when the worst is said it must be admitted that the known danger to health from garbage piles and "dumps" is relatively insignificant compared with the danger from other well-known but less popularly feared sources. Disease does not originate in garbage piles, however offensive they may be; the house-fly, however disgusting and annoying its habits, suffers from no disease transmissible to man, and does not convey disease unless it has access to material in which disease germs are present. The truth is that garbage disposal in large cities is more a matter of municipal housekeeping than of public health; proper methods of garbage collection and destruction must be urged rather from economic and esthetic considerations than on hygienic grounds. There are of course certain features in the handling of refuse and waste that need hygienic control, just as there are in street cleaning, but the problem is essentially not one of public health. At present in some cities the department of health is burdened with the task of caring for the city waste and its success or failure as a conservator of the

public health is too often measured by the frequency with which coal ashes are scattered in alleys or the length of time that decaying vegetable matter remains in tin cans in hot weather. In some cases the larger part of the annual health department appropriation must be expended for garbage collection and disposal, leaving only a pitifully small residue for other needs. To mention a single instance, the collection and conservation of garbage and ashes cost the Minneapolis Health Department in 1909 about $57,000, leaving approximately $43,000 for all the other activities of a health department serving a city of over 300,000 inhabitants.

One thing should be clearly understood by municipal authorities and by the general public, that regular collection and cleanly handling of ashes and table scraps is not one of the surest and most profitable ways of protecting health and preventing disease. Efficient administration of this branch of public work should not be allowed to take the place of measures that directly affect the public health.[3]

Few dangers to health have loomed larger in the public eye than that from "sewer gas." Elaborate and amazingly expensive systems of plumbing are required by law to be installed in every newly erected dwelling house in our large American cities. Plumbing inspection today occupies a large part of the working force of many municipal health departments. In Baltimore in 1908, to cite a single instance, this work was carried out by one inspector of plumbing, seven assistant inspectors of plumbing and one drain inspector at a total salary cost of $8,250 or about one tenth of the total salary appropriation for all public health work. And yet, if all the most recent and searching investigations such as those of Winslow and others are to be believed, the actual peril to health involved in the entrance of small quantities of sewer air into houses is so small as to be practically negligible. It may be questioned whether plumbing inspection, as ordinarily conducted, can be shown to save a single life or prevent a single case of disease. There is certainly no reason to suppose that any infectious disease is due to germs carried in sewer air. It might reasonably be maintained that slightly leaky gas fixtures are a much more serious menace to the health of house dwellers than defective plumbing. At all events our present knowledge affords small justification for the expenditure of public money to insure that the odor of peppermint does not enter our houses when oil of peppermint is designedly introduced into the house drains. It may be worth while for the house builder to satisfy himself of the character of the plumbing as of the character of the mortar, but compulsory inspection by public officials is hardly warranted on the ground of a high degree of demonstrated danger to the public health. It is certain, too, that the enforced installation of immensely complicated and elaborate piping and trapping systems simply adds to the cost of building without any compensating hygienic advantages. The plumbing ordinances of our large cities often contain inconsistencies and contradictions, what is required in one city being sometimes forbidden in another. A revision and simplification of municipal plumbing regulations, a minimizing of official inspection and especially an educa-

[3] Any one who fancies that to depreciate garbage disposal as a health measure is flogging a dead horse will be disabused of this impression if he has experience with the beginnings of a typhoid epidemic and learns how often public attention is diverted from significant issues like water-supply, milk-supply, and contact, by appeals to the prejudice against slovenly ways of handling harmless household refuse.

tion of the public to the fact that diphtheria, typhoid fever and scarlet fever have never been definitely traced to sewer air or bad plumbing are reform measures that might release a considerable sum of public money for use in really profitable lines of sanitary endeavor.

In the matter of heating and ventilation enormous sums have been spent and are being spent to "renew" the air in rooms and public assembly halls and to introduce "pure air" in what has been assumed to be necessary amounts. And yet if the work of Beu,[4] Heymann, Paul, Erclentz, Flügge,[5] Leonard Hill and others means anything it demonstrates that the whole effect from "bad air" and crowded rooms is due to heat and moisture and not to carbon dioxid or to any poisonous excretions in expired air. When all the effects of "crowd poison" upon a group of individuals in an experimentally sealed chamber can be eliminated by rapidly whirling electric fans it is useless any longer to look upon carbon dioxid as "a measure of danger." If we recognize that all the discomfort from breathing air in a confined space is due to a disturbance of the thermal relations of the body, the problem of ventilation becomes very different from what has usually been supposed. In temperate climates at all events it ought to be much simpler to provide for proper heat regulation of the body than to warm a large volume of outside air and introduce it into a building continuously or at stated intervals. It may well be asked whether the elaborate legal regulations governing the "supply" of air and the cubic feet of bedroom space have a real basis in scientific knowledge. If over-heating, moisture-content and stagnation of the air are the chief things to be avoided, may this end not be reached more effectively and less expensively than by present methods?

One conspicuous function at present required of or voluntarily exercised by health departments is the practise of terminal disinfection after cases of infectious disease. This has come to play a large part in municipal health activities and is responsible for an important share of the expense. In Boston, for example, in 1909, about one tenth of the annual appropriation was expended for disinfection. One of the most experienced New England city health officers has recently seriously questioned the value of such an expenditure.[6] After a study of the ratios of recurrences in certain diseases he concludes that, "Both theory and facts, so far as any data are available, indicate that terminal disinfection after diphtheria and scarlet fever is of no appreciable value." This view has met with strong support from the experience of a number of English health officials, even if it can not be regarded as conclusively proved. Every one now knows that the large sums of money spent in measures of disinfection directed against yellow fever gave little return in added safety. We can hardly take for granted that any process of combating disease is effectual simply because it is customary or traditional. It is evident that the whole question of disinfection needs to be studied afresh with a view to actual efficacy. It is not a subject for laboratory experimentation alone, but must be investigated as a problem of practical public health administration.

Other instances of the application of energy and money to measures apparently of slight or doubtful value might be cited, but those already given are fairly typical. The question that should be asked in every

[4] *Zeitschr. f. Hyg.*, 1893, 14, p. 64.

[5] *Zeitschr. f. Hyg.*, 1905, 49, p. 363.

[6] Chapin, *Jour. Amer. Public Health Assoc.*, 1911, 1, p. 32.

case is not whether a particular measure is entirely devoid of value, but whether it is the most effective way of utilizing available resources. As matters now stand there are a number of unquestionably valuable measures that can not be prosecuted with sufficient vigor because of the enforced diversion of funds into other and less profitable channels.

Efficacious measures may sometimes be distinguished from the fruitless or relatively unprofitable by their direct and unmistakable outcome in the saving of life and the prevention of disease. A few illustrations may be noted.

The importance of control and supervision of the sources of public water supply has long been recognized, but the importance of controlling the quality of the public milk supply, although frequently urged by sanitarians, is not always appreciated. At the present time in the great majority of American cities it is safe to say that for every case of infectious disease due to drinking water ten cases are caused by infected milk. It is difficult to secure adequate funds for the sanitary control of the milk supply. By sanitary control of milk is meant not the upholding of a rigorous standard of butter fat and total solids, but the maintenance of proper standards of cleanliness and health for dairy cows and especially the safeguarding the milk from infection during collection and transportation. Under some conditions the protection of the consumer against milk-borne infection may be best brought about by compulsory pasteurization of that portion of the milk supply which can not otherwise be raised to proper standard. Whatever method of control be adopted, it is certain that any genuine improvement in the character of a milk supply will be followed in the long run by a lessening in the amount of typhoid fever, diphtheria, scarlet fever and to some extent tuberculosis. The early detection of a single case of typhoid fever or scarlet fever on a dairy farm may be the means not only of preventing an extensive epidemic, but of avoiding the formation of scores of new foci which can in turn serve to light up subsequent cases for many years. Proper pasteurization of milk has been followed in many cities, as in Glasgow, Liverpool and London, by an immediate and material reduction in the amount of typhoid fever. In other words, the connection between an expenditure of public money and a direct return in prevention of disease can be more clearly demonstrated in the case of milk-supply control than in some other of the usual municipal health department activities.

The question whether the quality of a city milk supply can be more favorably influenced by inspection and supervision at the source, or by generally enforced and controlled pasteurization is one upon which there is still some difference of opinion among experts. There is little doubt, however, that simply as a matter of economy of administration much is to be said at present in favor of centralized pasteurization of a large portion of the supply. Viewed as a method for preventing a large number of cases of infectious disease at relatively small expenditure the pasteurization of milk certainly ranks high among effective health measures.

One of the important bacteriological advances of the last few years has been the discovery that a considerable number of healthy persons, convalescents or others, harbor disease germs and that these persons are important agents in spreading disease. The detection and proper treatment of disease-germ carriers, particularly in the more serious diseases and before or in the early stages of an epidemic, is now recognized as an important although difficult

task. The whole question of the control of germ-carriers is one that needs more careful study with a view to determining the actual results of the methods adopted. From this point of view, inspection of school children, especially at the beginning of the school year, is probably to be classed as a highly profitable activity, although it is to be wished that fuller and better-studied statistics were available.

Inspection of school children is highly valuable, also, in detecting various common congenital or acquired defects. If the defects are remediable, their early discovery may avoid development into permanently crippling disorders. In other cases, the application of simple corrective or palliative measures may greatly increase the industrial efficiency of the individual. If the defects are not remediable, their detection will at all events prevent the choice of unsuitable occupations, and will indicate desirable lines of education.

In rural communities, undoubtedly one of the simplest, as well as most important, health protective measures is the adoption, under compulsion if need be, of a safeguarded and standardized form of barrel privy.[7] A corollary hardly necessary to mention is the total abolition of the privy in all thickly settled towns. For lack of such regulations soil pollution occurs, the house-fly finds an opportunity to transfer disease germs from excreta to food, and typhoid fever and hookworm disease become constant plagues over wide regions.

In the campaign against tuberculosis it is perhaps too early to evaluate the numerous methods that have been proposed for lessening or eradicating this disease, but it is already evident that some are more directly repaying than others in proportion to the effort involved. Among the methods for which public funds are legitimately available none is more promising than the provision of sanatoria for advanced cases of consumption. Newsholme and Koch have shown that the general diminution in the death rate from tuberculosis observed in most countries can be more reasonably attributed to the establishment of sanatoria than to any other factor, and that in addition to its humanitarian advantages, the segregation and proper control of the advanced and dangerously infective cases is one of the most useful methods that can be employed by the community to protect itself against the spread of tuberculous infection.

Another field in which practical workers are convinced that certain measures have direct efficacy in saving life is that of infant mortality. It has even been said that for the expenditure of a certain sum the saving of a life can be guaranteed. Certain it is, that in few public health activities is the ratio between effort expended and results obtained so clearly seen. No one doubts to-day that prompt notification of births, education of the mother through any one of a number of agencies, and special provision for suitable feeding of infants during hot weather are factors that are bound to tell powerfully in the reduction of infant mortality. It may confidently be asserted that the degree of success achieved in this field will be limited only by the amount of endeavor the community is willing to put forth.

It is impossible at present to apply direct tests of efficiency to some measures that undoubtedly promote health. The influence of playgrounds, public baths, regulation of the hours of labor in extra-arduous industries and the like is real if it can not be accurately determined or estimated.

[7] See Public Health Reports for 1910, published by the Public Health and Marine Hospital Service, articles by Stiles and Gardner, and Lumsden, Roberts and Stiles.

Certain activities of a health department may be worth continuing for their educational value, although their direct utility may be questioned. Many topics need investigation in order to discover their real bearing upon the public health. Among these are such matters as the effect of a smoky atmosphere, the alleged nervous strain due to city noise and numerous important questions in the domain of food adulteration and contamination. Premature and drastic action by health authorities in matters concerning which there is profound disagreement among experts may cast discredit on other lines of activity in which there is and can be no difference of opinion.

For the present it seems worth while to emphasize more sharply than heretofore the distinction between public health measures of proved value and those that owe their existence to tradition or to misdirected and uninformed enthusiasm. Further study of the results obtained by certain of the usual and conventional health department activities is also much needed, and as a preliminary to such study the proper collection and handling of vital statistics is essential. It is poor management and unscientific procedure to continue to work blindly in matters pertaining to the public health, to employ measures of whose real efficiency we are ignorant and even to refrain from collecting facts that might throw light upon their efficiency.

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THE ENGINEERING SCHOOL GRADUATE: HIS STRENGTH AND HIS WEAKNESS[1]

So much has been written and spoken of late concerning the success or failure of the various engineering courses in our schools of technology that a reason should be offered for the introduction of this topic at this time. It is to be found, I think, in the general and increasing interest in these matters which is leading the practising engineers, the manufacturers, the men of affairs, in short, the consumers of the product of the engineering schools, to examine and evaluate the work of these schools. This interest has voiced itself more and more freely in the daily press, the engineering journals, and the occasional address. Some of the comments thus made are harshly critical, some are based upon sadly insufficient knowledge of existing conditions, but many are sane and helpful. It is the duty of those of us who are charged with the conduct of those courses to give heed to these utterances and to avail ourselves of the helpful counsel which many afford; but it is also a privilege which we may sometimes allow ourselves to present the case as it appears to us, and this anniversary occasion seems to suggest both retrospection and introspection.

The complexity of the educational problem is nowhere greater to-day than in the training of the engineer, using that term in a broad sense to include the man who applies his science to concrete ends, whether he be, for example, civil engineer, research chemist, or field geologist. The boundaries of all the sciences have been extended at a rate which has far outstripped any reasonable alteration of educational methods to meet these changing conditions; for, over against the charge of undue conservatism which is commonly made with respect to educational practises, should be placed the fact that seven years is the minimum period which must elapse before the ultimate success or failure of an educational experiment can be determined, and since the remodeling of a course or system of

[1] Presented before the Congress of Technology at the fiftieth anniversary of the granting of the charter of the Massachusetts Institute of Technology.

instruction to utilize successfully such of the newly acquired knowledge as it is possible to include must often be the result of gradually accumulated experience, it is plain that rapid and frequent alterations are both unwise and unprofitable. Such advances in scientific knowledge as, for example, those relating to wireless telegraphy, the turbine engine, or aeroplanes, which are of such immediate significance as to seem to imperatively demand a place in our courses of instruction, can not be allowed to displace other older topics of permanent importance, and in many cases these later developments of science are based upon abstruse principles, the proper teaching of which, in turn, demands much time.

The educational problem has, moreover, been rendered more difficult of solution by the concomitant increase in the number of men to be educated. It is no longer possible to give to the undergraduate that measure of personal attention from a mature teacher, of strong personality, which characterized successful teaching in the young manhood of our fathers, and resulted in the production of what may be termed "hand-made engineers." And, again, the increased ease with which our young men can now obtain educational advantages is sending to our schools a much larger proportion of students who, while they are earnest to a high degree and constitute a most desirable class of pupils, have not descended through generations of ancestors with scholarly or scientific instincts, and have not been surrounded by an atmosphere which is at all closely in harmony with that of the lecture room or laboratory. That most of these young men meet with success is the more to their credit; that some others meet with only measurable success in the scientific professions, and that distinct limitations, both professional and social, manifest themselves in the post-graduate development of some, is not surprising; but the cause is often mistakenly ascribed to faulty educational methods when in truth it is far more a question of raw material than of manufacturing process.

The product of the engineering schools has not escaped the universal demand that all products should advance in quality without increase in cost, which, in this instance, means with little or no increase in time expenditure. One needs only to review the conditions of the last quarter-century to realize that an extraordinary change has taken place in the position of the engineer in the community. None of the older professions have been called upon to face such kaleidoscopic conditions and it is not strange that there should be a dearth of men immediately adapted to meet the altered situation, or that many should be found to be partially lacking in the extremely composite training which would lead to complete command of the field. It may not be irrelevant to ask whether the so-called learned professions, so long regarded as superior to the engineering professions, would have fared distinctly better under a like extreme test.

The wholly successful engineer of the day (I do not speak now of the recent graduate) must be a man possessing a capacity for logical, quick and exact thought; a detailed knowledge of some portion and a broad knowledge of the whole of his professional field; and be master of a certain amount of the technique of his profession. He must have the ability to select and guide competent and trustworthy associates and to obtain from them loyal and willing service. He must be strong in his sympathies and generous in his public services, and while quick to enlist desired interest in his enterprises he

must be shrewd in detecting avarice or perfidy. He should be a loyal husband and father, and should find opportunity for that enjoyment of art and literature which will afford him present pleasure and ensure the happiness of advanced years. It is a matter for sincere rejoicing that the engineering profession has reached such a commanding position in our national life that only a man of this type can completely fill it; but the imperfect portrait just drawn is evidently that of a man for whom nature must have done much at the start, and toward whose efficiency many elements must have contributed. Of the need of such men there is no doubt, and it becomes a question of paramount importance to ask how far the engineering schools, as such, or, indeed, how far our entire educational machinery, can contribute to the desired end. The most obvious function of the engineering school is to afford a fundamental knowledge and understanding of the principles of the sciences underlying engineering operations. Failure to do this seems to be without excuse, yet it is almost inseparable from another important function, namely the development of the power to think (for there can be no adequate understanding of principles unless one can think logically in terms of them when considering concrete problems), and it is just at this point that much of the current criticism is aimed. The candid teacher must admit that there is truth in the charge that the graduates are too often lacking both in a capacity for logical thought and in an ability to command the knowledge which they actually possess to the degree needful for immediate or perhaps ultimate success in their vocation. But it should not be supposed that he is indifferent to this state of affairs. It is within bounds to say that it is the supreme desire of every worthy teacher to encourage power of thought rather than mere acquisition of knowledge on the part of his pupils and that he is constantly devising and testing new means to that end, but a moment's consideration will show you how much this depends upon personal contact —now so difficult in even the smallest practicable subdivisions of large classes— and will convince you that there must also be constant conflict of judgment as between the extent of the field to be covered in a given subject (rarely more than the minimum quantity now-a-days) and the time which can properly be spent in that drill which is necessary to develop the powers of the average student; for it is against the average student that the criticism is most valid. I do not make these statements to condone the conditions but rather to show you that the teachers recognize them, deplore them, and are striving against them, but the contest is an unequal one, at best.

Let it be remembered, moreover, that some responsibility for these conditions rests upon our public-school system, and also that the sort of thinking which the engineering professions demand is of a kind which is more exacting than is essential in the more common vocations, and that *no* system of education has yet succeeded in training a large proportion of exact thinkers, however much such a result is to be striven for. Let us also admit for our encouragement that, after all, there is a considerable proportion of our engineering graduates who *can* use their brains effectively and do have their knowledge in available form, and my observation leads me to believe that there is a much larger proportion who appear deficient in these respects at graduation who develop unexpected power when they have opportunity to concentrate their efforts in a more limited field. Remember that many of these youths have been in some sort of educa-

tional training for a continuous period of fifteen to seventeen years, during which there has been a constant (but sometimes unwise) increase in the pressure put upon them to cover more ground. Is it strange that they have lacked an opportunity to sort their immense stock, or to become familiar with it? They are, I think, entitled to charitable consideration for a time after entering their vocation, but if, as a class, they are deficient after three years, the criticism of them or of their training certainly becomes valid.

The public has a right to look to the engineering schools for sound instruction in fundamentals, including, of course, physics and chemistry, as well as the mathematics and drawing which must form a part of the equipment of every competent engineer. In addition, they may demand that the fundamental principles and something of the technique of those subjects which are of general application within a given profession shall be thoroughly taught, and that this shall be done with reference to development of power and the inculcation of useful habits, rather than the mere acquisition of information. While this is a demand which no engineering school would desire to evade, let us recognize that it is, of itself, no light task to accomplish.

But in our epitome of the distinctly successful engineer of maturer years was included *breadth* of knowledge within and without his profession, the quality of leadership, which means power of initiative and a knowledge of men, and the ability and inclination to fulfill the requirements of good citizenship. Are the graduates from the engineering schools, as a class, in line to develop thus symmetrically? Let us admit again that many are not and that that is the occasion of the general charge of "narrowness" and inadequacy which is directed against our courses. But here again I venture to assert—not, however, in a spirit of complacency—that the situation is more complex than is generally admitted, and that there is a good deal that is encouraging in the situation. Recall once more how short a time it is since the engineer has occupied a position in the community which is recognized to be of equal dignity with that of the so-called learned professions, and recall how recent is that evolution of our industrial system which has as its most important feature the recognition of the fact that the engineer and the financier, if not combined in the same individual, must be on a parity with respect to influence and authority, if efficiency—the watchword of the hour—is to result. Is there not cause for congratulation that some have been found in the engineering ranks capable of meeting this surprising increase of responsibility rather than ground on which to pronounce the general result of engineering education a failure, as some seem inclined to do?

It is well known that the Massachusetts Institute of Technology endeavors to stand to-day, as it has from its beginning, for the largest measure of breadth of training and education which is compatible with thoroughness of fundamental scientific instruction. An inspection of its courses as prescribed for the various professions shows that, notwithstanding the pressure resulting from the growth of science and technology, about one eighth of the total hours which a student spends at the institute is devoted to subjects which are cultural studies, using that term to distinguish them from those scientific subjects which may be regarded as tools of trade, although many of these, notably such as physics, chemistry, biology or modern languages, if properly taught, will contribute much to the cultural development

of the well-rounded engineer and the useful citizen outside of his strictly professional field. In this respect the institute has been a pioneer in engineering education and its founders took a position far in advance of the times. Nevertheless the Institute has not escaped the charge of narrowness and this has sometimes come, alas, from some of her own sons who were not over-zealous in availing themselves of the opportunities actually offered during their student days. More specifically, as has already been implied, it is charged that the graduates from engineering schools are not as a class showing themselves capable of development into men who can occupy successfully the commanding positions already described; and again the institute is not exempted. So far as this charge relates to breadth of view within the professions it is the immediate and vital concern of these schools. So far as it relates to those traits which go to make up the accomplished man of affairs it is serious, and demands earnest attention, but the remedies are less obvious; for these remedies must mean the superimposing upon an already heavy burden, a task which should be begun in the home and largely completed there; a task, indeed, which no college has satisfactorily met with respect to all of its professional or non-professional graduates. So far as books can help, an added year of student life would seem to afford a remedy and there has been much discussion of the desirability of extending the undergraduate course to five years, and of making the engineering schools graduate schools. The arguments can not be reproduced here, but it seems clear that the added expense incurred and the increased age at which the young man enters his life work, militate seriously against the adoption of either of these as a universal procedure. For those to whom such opportunities are open they are likely to prove of great value, and it is interesting to note that each year seems to bring to the engineering schools a larger number of young men who have already graduated from some college, and encouragement is also to be found in the fact that more and more of these men have planned their courses during their college years with reference to later work in the technical school, a procedure which is much more to their advantage than what Professor Jackson refers to as a "butt-joint" between a general college course and a later engineering course. It should also be remembered that this is a recent educational development and that these men have not yet been tried out.

One serious difficulty which technical schools are encountering has been frequently referred to by recent writers, but deserves a mention here, namely, that of securing and holding broad, cultured teachers. Specialization has seriously invaded the teaching profession, especially in scientific lines where the mastery of any large field of knowledge to a degree corresponding to the needs of the expert is rarely possible. The specialist is apt to use the microscope far oftener than the field glass and this habit is partially reproduced in his students. It is encouraging to note that certain schools are now recognizing the need of men who are efficient teachers with a broader outlook, to deal especially with the younger men. They are recognizing that not every eminent specialist or successful investigator is a successful teacher, more particularly in this very matter of breadth of view, and are leaving the specialists greater opportunity for the presentation of their specialties to the older classes, while improving the instruction in the more general courses. It is obvious that these difficulties are enhanced by the larger financial rewards which tempt the broad-minded

engineer away from the schools—a serious matter which can not further be discussed here but lies close to the root of much of the cause for criticism. It is interesting to note how even a single instructor, who keeps himself and his pupils closely in touch with current events, and leads them to understand that no single human attainment, however complete or final it may appear, necessarily represents the best that can be done, and that it may well be the privilege and the duty of any one of his hearers to extend the boundaries of such attainment, will give an impetus to successful effort that will be felt in the entire lives of his pupils. It is to be hoped that no one of us is unable to recall with gratitude some such instructor. We need more of them. A single instructor, again, who exemplifies the cultured scholar and gentleman in ease of manner and grace of diction does more for the cause of scholarship and culture than any quantity of sound advice can do; for, I fear that it is utopian to hope that a majority of the students with whom the study of engineering is the main purpose will ever believe that any man is disinterestedly sincere in his advice regarding such subjects as literature, language, art or economics, unless he makes it quite clear to them that these subjects have a distinct significance to him and are a part of his life. Just here lies one of the great obstacles to the elimination of "narrowness."

If the inculcation of breadth of view and love of the refined in life is difficult, the development of qualities of leadership is even more so. That these qualities are largely conferred at birth will, I suppose, be generally admitted, but I take it that the criticism of lack of leadership is really directed toward an alleged culpable lack of facility in getting the best from others, of appreciating the point of view of others, or of presenting our own views to others. If this indicates a failure on our part to stir the ambitions of our students to avail themselves of opportunities which come to them, or to plan for themselves a really worthy career, then we are at fault; but if it means that the faculties of engineering schools should further encourage those forms of activity commonly designated as "college life," then I believe that we are on debatable ground. Of the importance of those traits which enable a man to win the confidence and respect of his fellow men, to "succeed" among men, no one could be more conscious than I. In individual cases they may indeed be more potent factors than accuracy of scientific knowledge in securing preferment, and any man is fortunate who combines engineering skill with ease of manner and persuasive speech. But the real function of these schools is, after all, the training of capable engineers and it is very easy to pass the line beyond which there is grave danger that both the quantity and quality of individual attainment will be lowered because of time and energies devoted to social affairs. By all means let the schools realize their responsibilities for the development of men as well as engineers, and encourage by precept and especially by example an interest in all that tends toward a better understanding on the part of our students of their human relations, including prudent encouragement of the so-called "student activities." But let those who lack a realization of the great changes which the student life at our technical schools has already undergone in the last few years, and who therefore constantly clamor for more of what is called "college life," reflect that one of the greatest assets which a graduate from one of these schools can take with him when he leaves it is the well-established habit of "doing a

day's work in a day," of meeting his obligations on time, and let him realize that this can not be reasonably demanded if the instructors must in fairness accept excuses because of an undue diversion of time and energy to other things. Although the sciences actually owe many of their advances to "grinds," it is probably fortunate that few of our engineering graduates of to-day belong to that class; but there is little likelihood of an undue increase in the proportion of such over-developed scholars under existing conditions! An impartial survey will, I believe, show that our recent graduates are, as a body, less open to the charge of lack of adaptability, and want of social resources than formerly and that they are improving in this respect as the need of such improvement is more generally realized, and also that there is ground for the belief that this has so far been accomplished without serious sacrifice of professional efficiency.

In what I have just said I have had in mind particularly the business and social relations of the young engineer with his colleagues and superior officers. It is often stated that some or many of the graduates also lack an appreciation of the proper way to deal with those whose labors they must direct. This, again, is doubtless in some considerable measure true, and in fact it can hardly be otherwise when nearly all of these young men pass directly from the public schools to the higher educational institutions. It is not, however, true that no effort is made to bring this phase of their future responsibilities to their notice, for not only is the subject discussed in its general aspects from the lecture platform, but the young men are advised to secure summer employment as far as possible to the end that they may learn to know industrial conditions.

In this connection I should like to point out to those in control of our industrial establishments that there is a large store of energy, combined with a desire for opportunity to work and ability to render intelligent and willing service, which goes to waste in the summer because our students are unable to secure temporary positions. This is particularly true in the industries into which the men in whom I am especially interested, the chemical engineers and chemists, will go. I am, of course, aware that the net return in value to a concern from this temporary service is not relatively large, especially during the first summer, and that in certain industries there is a risk in trusting to the integrity of these men with respect to information acquired regarding operating methods. But I can not avoid the conviction that if the industrial managers would cooperate with the engineering schools in the consummation of an arrangement whereby young men whose ability and character could be vouched for could be given summer employment for two or three of the successive summers intervening during the four years of study, the concerns thus cooperating would actually find that they would derive appreciable benefit from the plan. That it would enable the schools to add at least fifty per cent. to their efficiency so far as these students are concerned, I have no question whatever, and surely no better means could be afforded for the acquisition of a knowledge of the problem of the laborer in the works. Let me add that I do not urge the placing of these young men at once in positions of responsibility but rather in such positions as will afford them working experience under industrial conditions. It seems to me, however, that it is not improbable that, say, in a third summer the majority of such men might be utilized to much advantage in the immediate direction of specific processes or operations,

they themselves acting under general or specific direction.

Some of us are just now concerned to know how with respect to chemical engineering we can give the young men an opportunity to come into contact with the actual practise of their profession before they leave the school, and the advisability of the equipment of laboratories of chemical engineering is under careful consideration. While it is no doubt true that, from its nature, chemical engineering offers less abundant opportunities for industrial work during the vacation interval in a student's career than many other professions, notably less than civil engineering, and at the same time is a profession the actual practise of which it is exceedingly difficult to reproduce in an educational plant, I suspect that similar general conditions exist in other lines. Here, again, is a problem with no small dimensions or importance with which we are wrestling, and one step toward its solution may be made through the greater cooperation on the side of the industrial managers for which I have just appealed.

If I have dwelt more upon the alleged weaknesses of the engineering school graduates than upon their strength, it is because the latter is attested by the engineering advance of the recent past to which they have contributed to an extent which would not have been possible had not the majority of them received from the schools an education and training which has proved useful, dependable and stimulating.

I believe that the large majority of the engineering school graduates are virile, intelligent, industrious fellows, with sound habits of thought and great capacity for work, ambitious to make the best of themselves, possessing a sincere desire to acquit themselves honorably, both in private and public life and with an increasing ability to do so. As such, we, their instructors, honor them and ask your cooperation, advice and encouragement in our efforts to give to them what they deserve at our hands. We ask you also to recognize that while for the moment the rapidly changing social and industrial conditions may have outrun our ability to adapt our educational practise to them, we are not lacking in an appreciation of the significance of these changes, or of our obligations for the future.

HENRY P. TALBOT

MASSACHUSETTS INSTITUTE
OF TECHNOLOGY

CHRISTIAN ARCHIBALD HERTER

THE death of Dr. Herter on December 5, 1910, terminated a life of only forty-five years, a life which had been rich in endeavor and was synonymous with the conception of intellectual cultivation as the happiest outcome of temporal existence.

Dr. Herter graduated from the College of Physicians and Surgeons in 1886 at the age of twenty-one and in the same year married Miss Susan Dows, who throughout his career sustained him with sympathetic power and intelligent appreciation of the value of his work. After graduation he studied with Welch in Baltimore and with Forel in Zurich. He then began to practice medicine, specializing in the diseases of the nervous system, on which subject in 1892 he published his first book. His mind, which was ever active, did not permit him to receive his knowledge through second-hand sources, and in 1893 the upper floor of his house was converted into a series of laboratories in which work could be accomplished according to his liking. It was the beginning of the "Laboratory of C. A. Herter," the contributions of which are known throughout the world. To appreciate the significance of all this, it should be remembered that with the exception of the work in the pathological laboratories of the colleges, the work of the board of health, and the work done by Dr. Meltzer, there was practically no scientific

investigation in medicine worthy of the name in New York city at that time. What was true of New York was essentially true of the country at large. Here then was one who combined the practice of medicine with the science of medicine as few men of his generation in this country had done. Failing strength in his later years caused him to relinquish entirely private practice and devote himself to his laboratory as the center of his intellectual activity. It was interesting to note the attitude of an audience when Herter spoke. To many, he was one of them, a practitioner of medicine, and yet to all he was one who had carried medical science to a higher plane, had enveloped medical doctrines with new authority, and the clear, incisive words as they flowed from his lips were followed by his listeners with attentive and almost reverent regard.

Dr. Herter found the study of the nervous system so abounding in confusions that he soon turned his attention to chemical problems, especially those connected with pathological conditions. Among those intimately associated with him in this work have been E. E. Smith, A. J. Wakeman and of late H. D. Dakin. Dr. Herter's work included researches concerning uric acid, autointoxication, the toxic properties of indol, uremic intoxications, the production of serous atrophy of fat, nitrifying bacteria, acidosis, adrenalin glycosuria, gall-stones, bacterial infections of the digestive tract, intestinal infantilism, the influence of dietary alterations on the types of intestinal flora, and the action of sodium benzoate on the human body. The last-named piece of work was part of an investigation conducted by a commission appointed by President Roosevelt, and conclusively demonstrated, so far as physiological investigation can demonstrate, that sodium benzoate if given in the quantities in which it is used as a food preservative, is harmless.

Between 1897 and 1902 Dr. Herter was professor of pathological chemistry at the University and Bellevue Hospital Medical College. Although the lectures were optional, the room was always crowded and his hearers carried away with them breaths of real inspiration. The lectures were published in book form and were translated into Italian. In 1903, he was called to the chair of pharmacology and therapeutics at the College of Physicians and Surgeons, a position he held till his death.

He was trustee of the Rockefeller Institute and a moving spirit in the creation of the Rockefeller Hospital. Only in the last days of his life was he permitted to see this wonderful hospital accomplished, the dream of many years realized, and almost daily as his strength permitted he would be taken thither to rejoice in its work and its future.

He founded the *Journal of Biological Chemistry*, the first of its kind in the English language, and his friends have united in the endowment of this journal as the most fitting memorial to his life's work.

Two Herter lectureships, one at the University and Bellevue Hospital Medical College, the other at the Johns Hopkins Medical School, were founded by Dr. and Mrs. Herter, and have served to bring to this country many of the greatest scientists in Europe. This has been the public service of a far-seeing mind.

Herter had a wide-spread acquaintance among the scholars of his time both in Europe and at home, and his work and worth were universally respected and admired. He delighted in the friendship of those who could inform him, he was a true councillor of those who went to him for advice, and he encouraged young men. The blood of the true artist was his. Music and painting contributed to the pleasures of his life. His friends loved him and he loved his friends.

GRAHAM LUSK

SCIENTIFIC NOTES AND NEWS

AT its annual meeting on May 10, the American Academy of Arts and Sciences voted to award the Rumford premium to Professor James Mason Crafts "for his investigations in high temperature thermometry and the exact determination of new fixed refference points on the thermometric scale."

THE Academy of Natural Sciences of Philadelphia has elected as correspondents the following: David Starr Jordan, Edmund Beecher Wilson, Jacques Loeb, William Bullock Clark and Thomas Wayland Vaughan.

A complimentary banquet to Professor H. E. Armstrong, F.R.S., took place at the Hotel Cecil on May 13, attended by a number of distinguished chemists and over two hundred of his former students.

At the annual meeting of the British Iron and Steel Institute the Bessemer gold medal for 1911 was presented to Professor Henri Le Chatelier, of Paris. The Carnegie gold medal was awarded to Mr. Felix Robin, who has conducted researches on the wear of steels and their resistance to crushing. Carnegie research scholarships have been awarded to Messrs. W. M. Guertler, of Berlin; G. Hailstone, of Birmingham; R. M. Keeney, of Colorado, and G. Dietrich Röhl, of Freiberg. Messrs. J. Newton Friend, of Darlington, and T. Swindon, of Sheffield, have had additional grants made to them to enable their researches to be extended and completed.

The Association of American Physicians, at its meeting in Atlantic City, elected Dr. J. George Adami, Montreal, president and Dr. Lewellys F. Barker, Baltimore, vice-president.

The annual general meeting of the Society of Chemical Industry is to be held in Sheffield on July 12. Dr. R. Messel has been nominated as president, and Sir William Crookes, F.R.S., Dr. G. G. Henderson and Messrs. H. Hemingway and W. F. Reid have been nominated as vice-presidents.

Professor Charles Derleth, dean of the College of Civil Engineering of the University of California, has been elected president of the San Francisco Association of the American Society of Civil Engineers.

Dr. Francis H. Slack, of the University of Kansas, Lawrence, formerly director of the Boston Bacteriologic Laboratory, has been offered the secretaryship of the Boston Board of Health.

Dr. L. D. Swingle, of Nebraska Wesleyan University, has been appointed research parasitologist in the Wyoming Agricultural Experiment Station.

Dr. Burt G. Wilder, who last year became emeritus professor of neurology and vertebrate zoology at Cornell University, will hereafter live in Brookline, Mass., where he was born in 1841.

Dr. F. P. Gulliver, of the Geological and Natural History Survey of Connecticut and secretary of the section of geology and geography of the American Association for the Advancement of Science, is recovering from a somewhat severe operation that he underwent on May 17.

Professot Ernst Haeckel, of Jena, now in his seventy-seventh year, broke his hip bone recently, while standing on a stool to obtain a book from a library shelf.

Dean H. C. Price and Professor W. R. Lazenby, of the Ohio State University and Agricultural Experiment Station, have been granted leave of absence for next year, the former for study in one of the German universities and the latter for travel and the study of forestry in Europe and South America.

For the year 1911–12 the following will be absent on leave from the University of California: R. T. Crawford, associate professor of practical astronomy, and G. P. Adams, assistant professor of philosophy. Leave of absence for the first half-year has been given to A. C. Lawson, professor of geology; R. O. Moody, assistant professor of anatomy; C. A. Noble, associate professor of mathematics, and E. E. Hall, associate professor of physics; for the second half-year, to D. N. Lehmer, associate professor of mathematics.

Professor J. W. Beede, of the University of Indiana, will continue his studies of the Permian problem in Oklahoma the coming summer. The work, which will be under the direction of the Oklahoma Geological Survey, will consist in the endeavor to trace the Pennsylvanian-Permian contact from southern Kansas across Oklahoma as far as the Arbuckle Mountains.

Dr. Henry Head, F.R.S., will deliver the Croonian lectures on "Sensory Changes from Lesions of the Brain" before the Royal College of Physicians of London on June 13, 15, 20 and 27.

EIGHT lectures on the Hitchcock Foundation, at the University of California, were delivered by Professor Harry Fielding Reid, of the Johns Hopkins University, on the evenings of March 28, 29, 30 and 31, and of April 3, 4, 5 and 6. The general title of the course of lectures was "The Mechanics of Earthquakes."

THE annual public address before the chapter of Sigma Xi in the University of California was delivered May 11, by Sir John Murray on the subject of "The Floor of the Ocean." The lecture was illustrated with a fine series of lantern slides largely based upon the results of the Atlantic Expedition of the Norwegian fisheries steamer *Michael Sars* in the summer of 1910.

ON the evening of Friday, May 12, Professor G. J. Pierce, professor of botany in Stanford University, lectured before the society of Sigma Xi of Indiana University on "Vegetation and Civilization."

PROFESSOR ROSS C. PURDY, of the ceramics department of the Ohio State University, was recently elected president of the local chapter of the Sigma Xi Society. Professor Charles S. Plumb was elected vice-president and Professor E. F. Coddington, secretary.

PROFESSOR WAYLAND MORGAN CHESTER gave an illustrated lecture before the departments of geology and biology of Colgate University, on May 25. His subject was "The Bermuda Islands and their Life."

A MONUMENT has been erected at the National School of Agriculture, Montpelier, France, in recognition of the work of the late Gustave Foëx, a former president of the school, in improving the culture of grapes.

THE Carnegie Fund Committee of France recently awarded the foundation gold medal to the widow of the French doctor, G. E. Mesny, who died while engaged in treating plague victims at Harbin, China.

MRS. WILLIAMINA PATON FLEMING, curator of astronomical photographs in the Harvard College Observatory, died on May 21, aged fifty-four years.

NATHANIEL WRIGHT LORD, for thirty-one years professor of mineralogy and metallurgy, director of the school of mines and first dean of the college of engineering of the Ohio State University, died at his home on May 23, aged fifty-five years.

THE New York assembly passed on May 22 the bill previously passed by the senate incorporating the Carnegie Corporation of New York. The incorporators mentioned in the bill are Andrew Carnegie, Elihu Root, Henry S. Pritchett, William N. Frew, Robert S. Woodward, Charles L. Taylor, Robert A. Franks and James Bertram. Its purposes are defined as follows: "To promote the advancement and diffusion of knowledge and understanding among the people of the United States, by aiding technical schools, institutions of higher learning, libraries, scientific research, hero funds, useful publications, and by such other agencies and means as shall from time to time be found appropriate therefor.

THE gentlemen's conversazione of the Royal Society was held at Burlington House on May 10. The fellows and guests were received by Sir Archibald Geikie, K.C.B., president of the society. The Hon. R. J. Strutt gave a lecture on the afterglow of the electric discharge and on an active modification of nitrogen, and Mr. Joseph Barcroft lectured on adaptation to high altitudes in relation to mountain sickness. There were as always a large number of interesting exhibits.

ADVANCED students or teachers of zoology or botany desirous of working at the Bermuda Biological Station for Research for a few weeks this summer should communicate at once with Professor E. L. Mark, 109 Irving Street, Cambridge, Mass.

THERE is a vacancy in the Bureau of Soils, United States Department of Agriculture, at Washington, D. C., for the position of soil scientist in the laboratory of physical and chemical investigations. The government is endeavoring to secure the best qualified man available for this work and has no particular individual in view. The position requires a high order of scientific training, equivalent to that required by the leading American universities for a professorship in physical chemistry. As the work will also be largely ad-

ministrative in character, a wide and successful experience in an executive capacity is very essential. A broad field exists for scientific work of a high grade and for original research and investigation which offers rare opportunities for the making of a reputation and for a career in the public service. It is customary to publish the results of investigations in government publications with the name of the scientist making the study or investigation. Those persons who are qualified and who wish to be considered for this position are invited to submit for consideration a statement of their qualifications, references to their published works, and other pertinent material to the United States Civil Service Commission, at Washington, D. C. In general, the methods of procedure in filling this position will be similar to those of an educational institution, whose boards of trustees or governing officers desire to fill professional or technical positions. The qualifications and fitness will be determined by an impartial board of scientists. As the selection for this position will be made about the middle of June of this year, it is suggested that persons interested communicate with the United States Civil Service Commission, at Washington, D. C., at an early date. The entrance salary for this position is $3,000 per annum.

The Health Officers' Association of New Jersey, adopted a constitution and closed its charter membership on May 24, at a dinner and meeting held at Newark. Thirty-three health officers, inspectors and members of local boards of health were present and the association had as its guests two members of the State Board of Health, Col. G. P. Olcott and Dr. R. C. Newton, also Dr. A. C. Hunt, chief of the division of medical inspection; Dr. R. B. Fitz-Randolph, chief of the food and drugs division; Mr. George W. McGuire, chief of the dairy division, and other representatives of the executive staff of the State Board of Health. The objects of the association are the advancement of knowledge relating to the public health, and the promotion of social intercourse among health officials. Five regular meetings in the year are provided for, to be distributed through the winter months. The active membership includes as eligible employees of the state and local boards of health (*i. e.,* health officers and sanitary inspectors), licensed by the State Board of Health, or of the equivalent grade. Members of the state and local boards of health are eligible to associate membership. The officers, elected at a previous meeting, are as follows: *President,* Chester H. Wells, health officer, Montclair, N. J.; *Vice-president,* John O'Brien, Jr., health officer, Plainfield, N. J.; *Secretary-Treasurer,* J. Scott MacNutt, health officer, Orange, N. J.; *Chairman of the Executive Committee,* Dr. Edward Guion, health officer, Atlantic City, N. J.

In 1880 gold was produced in Alaska to the value of $20,000. In 1909 the amount mined was valued at more than $20,000,000. In 1888 silver was first produced in Alaska, to the value of $2,181; in 1909 the value was $76,934. In 1902 copper was first produced, to the value of $41,400; in 1909 its value reached $56,211. These and other statistics of production are shown by Alfred H. Brooks, of the United States Geological Survey, in "Gold, Silver, Copper, Lead and Zinc in the Western States and Territories," published as a separate chapter of the volume "Mineral Resources of the United States in 1909." The Alaska Yukon placer district had in 1909 the most profitable season since mining first began there, a quarter of a century ago. According to the Geological Survey's returns the value of the gold output was $11,580,000, as compared with $10,323,000 in 1908. The production in Seward Peninsula fell off, owing to the facts that many of the richest placers have been mined out and that no preparations have been made for mining the extensive deposits of low-grade gravels. With the construction of large plants an increase may be looked for. The great possibilities of the Alaskan gold-bearing gravels can be recognized when a comparison is made of the recovery from the placer workings of the territory and those of the United States. In 1909 the average recovery for Alaska was $3.66 a cubic yard, while for the United States the recovery was only 12 cents.

UNIVERSITY AND EDUCATIONAL NEWS

MR. T. C. DU PONT has given $500,000 to the Massachusetts Institute of Technology toward its proposed new site. Announcement is also made of two bequests of about this amount: a trust fund of between five hundred and six hundred thousand dollars, created by Francis B. Greene some five years ago, will be received by the institute for the assistance of students, and it will receive nearly $500,000 from the bequest of Mrs. Emma Rogers, widow of William B. Rogers, the first president of the institute. These large gifts in addition to the $100,000 for ten years appropriated by the state, will make it possible for the institute to purchase a new site and erect the necessary buildings.

BY the will of Mrs. Lydia Augusta Barnard, of Milton, Mass., Radcliffe College received $75,000 for a dormitory and $40,000 for scholarships, and Harvard University receives $60,000 for the study of jurisprudence and legislation.

THE Harvard College corporation has voted to approve the establishment of a school for advanced instruction in medicine in general accordance with a plan proposed by the Faculty of Medicine; the intention is that the school shall go into operation at the beginning of the academic year 1912–13, that it shall have a separate dean and administrative board, and that it shall ultimately absorb the Summer School of Medicine. Instruction in the school is to be provided if possible by the existing departments of the Medical School, but, if necessary, instructors will be appointed specifically for giving instruction in the new school. The courses of instruction will consist of all-day courses, intermittent courses and research courses.

THE preamble of the statute exempting students in natural science and mathematics from examination in Greek passed congregation at Oxford on May 16 by a vote of 156 to 79.

PLANS for the extension of the work of the department of physiology of Columbia University are being carried out. Three additions to the staff have been made: Frank H. Pike, of Chicago University, to be assistant professor; Horatio B. Williams, of Cornell, to be an associate, and Donald Gordon to be an instructor. Dr. Williams is spending the summer in Europe visiting several laboratories and arranging for the purchase of apparatus for electrocardiographic and other work. Professor Burton-Opitz will have charge of the instruction of the medical students and Professor Pike of much of the work in general physiology. A course in clinical physiology, dealing with the application of physiological methods to problems of clinical medicine has been established. Changes in the laboratories will be made during the present summer. The income of the George G. Wheelock Fund is to be devoted to the extension of the library. The chief professorship of physiology, held by Frederic S. Lee, has been entitled the Dalton Professorship, in memory of John C. Dalton, who was in point of time the first experimental physiologist of America and gave distinguished services to the Columbia School of Medicine for thirty-five years.

DR. S. O. MAST, professor of botany at Goucher College, has resigned in order to accept an associate professorship in zoology in the Johns Hopkins University. He will take up the duties connected with his new position at the opening of the next school year.

AT the University of California J. G. Fitzgerald has been appointed associate professor of bacteriology; J. Frank Darnel, assistant professor of zoology, and A. U. Pope, assistant professor of philosophy. Instructors have been appointed as follows: C. J. Lewis, in philosophy; Frank Irwin and Thomas Buck, in mathematics; C. L. Baker, in mineralogy and geology; D. W. Morehouse, in astronomy.

DISCUSSION AND CORRESPONDENCE

THE TEST OF VITALISM

TO THE EDITOR OF SCIENCE: Such attempted definitions of vitalism as those furnished by your correspondents fail to give a clear conception of the idea usually conveyed by the word. Its real significance, I think, is better

expressed by a hypothetical test. Assume any healthy organic cell or organism to be instantaneously resolved into its constitutent particles so that they are suddenly reduced to inorganic substances. Then assume that it were possible to instantaneously reassemble each of these particles in precisely the physical relations in which they before stood to each other with the same temperature conditions and let each particle be instantaneously impressed with motions the same in direction and amount which they possessed at the instant of dissolution. If then the reassembled body goes on as an organism as before, it will be proof that life is but the operation of what are known as the ordinary mechanical and chemical forces. If not, it will be proof that a certain tertium quid no matter what is lacking to convert the body into an organism. This tertium quid constitutes the element of vitalism as it is generally understood. It does not necessarily imply the imposition of some new and foreign principle or substance on the materials constituting the body. It may be nothing more than the bringing into activity of forces or affections previously latent in the materials themselves. The former seems to be the theory of the extreme vitalists who look on the soul as something distinct from the body, while the latter seems to correspond with the views of those vitalists who regard matter as in the language of Tyndal impressed with the potency of all life.

In a last analysis, however, no sharp line of distinction can be drawn between the vitalists of the latter type and the non-vitalists. For it seems clear that if this tertium quid be in any manner latent in the inorganic particles, it may be looked on as undisclosed chemical attributes of the matter itself. It becomes rather a question of definition, what are chemical or mechanical attributes? These terms in their popular significance are confined to forces subject to comparatively simple mathematical laws. I think few mathematicians would concede that such laws, however numerous, could furnish an equation which would satisfy the complicated movements involved in the life history of an organism. The forces at work must be something more than those ordinarily understood as mechanical or chemical.

When to this is added the element of self-direction or self-selection, which in its higher forms assumes the aspect of self-consciousness, we have crossed a barrier which apparently can never be bridged in terms of mechanical or chemical forces and which must seemingly forever remain a mystery, whose solution we are no nearer than were the old Greek philosophers. The weight of such evidence as we have seems to favor a modified vitalist or it might be called mechanical vitalistic view. All vital activity is measurable in terms of energy expended. An infinite chain of physical causation determines every vital movement. No power of self-determination beyond such causation could exist without the power to create energy. The activity of the organic mechanism may be suspended indefinitely and again revived if no disarrangement of its constituent particles occur. On the other hand, no mathematical laws can be conceived of which could express the operation of the forces which direct the life history of the individual. Are we not brought back to the old theistic or deistic conception of an inscrutable power pervading all nature in whom we live and move and have our being?

Walter S. Nichols

New York

A PLEA FOR THE USE OF REFERENCES, AND ACCURACY THEREIN

To the Editor of Science: It has been the writer's duty, during the past two or three years, to compile, or to assist in the compiling of, a number of extensive bibliographies and lists of references to the literature of various chemical subjects, and during this work it has been often impressed upon him with what laxity and apparent disregard of consequences some authors handled—or failed to handle—their references to prior work. The same difficulty is all too often experienced when looking up some apparently simple subject.

For instance, an article was recently desired by a chemist employed in certain synthetic

work, describing a method for the reduction of certain compounds, referred to in a scientific paper, without further information, as "Ladenburg's" method. Persistent search of the indices of the journals where the paper would most probably have appeared yielded only a brief polemic note, *which made no reference to the appearance of the original paper!* The proper method was finally found as a side-issue in a paper on oximes, through the use of a very recent hand-book of laboratory methods, the author of which had very probably gone through the publications of Ladenburg until he struck this article. Had the author of the paper from which the reference (?) mentioned in the first sentence of this paragraph taken half a minute's more time and given this reference, and given it correctly, he would have saved others literally hours of searching.

Another instance. Certain important and excellent work was recently done in Philadelphia on methods of sewage disposal. As one feature of this work, a large number of determinations of the amounts of nitrates present were made by what was referred to as "McRae's narcotine test," no reference or description of the method being given. It became necessary elsewhere to find the details of this method, and it so happened that the usual chemical abstract journals had missed this paper. As a last resort, the "Index Medicus" was looked through, and finally a reference to the paper was found, though even here the citation given was not the one where the paper would usually be most easily found. Had the author of the report of the Philadelphia experiments given a half-line reference to the place of publication of this method, he would have saved an hour or more of the time of one or two men in a busy laboratory.

Fortunately, cases of the total omission of an important reference are comparatively rare, though the embarrassment and additional work such omissions cause is quite sufficient to warrant their being judiciously guarded against. More frequent, and sometimes equally troublesome, are the cases where erroneous page, volume or year numbers are given, or sometimes even an erroneous journal or book name. A case recently shown me was that of an author who referred some eight or nine times in a paper of four pages, to the work of another author "Schreiber";—"Schreiber's" correct name was "Fleischer"!

The movement for the unification and coordination of zoologic nomenclature, although differing in many considerable respects from what a similar movement in other sciences would be, includes not a few phases which could well be studied and adopted by non-zoologic contributors to the literature of science.

F. ALEX. McDERMOTT

HYGIENIC LABORATORY,
WASHINGTON, D. C.,
May 11, 1911

A TREMATODE EPIDEMIC AMONG ENGLISH SPARROWS

DURING the months of June and July, 1910, English sparrows in the vicinity of the College of Agriculture of the University of Wisconsin at Madison were found to be very commonly infected with a trematode parasite which was identified as *Monostoma faba* Bremser. This parasite, which forms conspicuous cysts in the skin of the abdominal region, has long been known in Europe, but has heretofore been reported in only one or two isolated cases on this continent. Attention is called to the matter here, as it may be of general interest to helminthologists, and in order that others may be on the lookout for the parasite in this country. In this locality the parasite appeared to cause a certain mortality, and it is possible that it may become one of the means which will help to check the increase of the English sparrow in North America. Unfortunately, it attacks other small passerine birds of several families as well. A more detailed account of the present epidemic is being published in the *Bulletin of the Wisconsin Natural History Society,* Vol. 9, Nos. 1–2, pp. 42–48, pl. 5, April, 1911.

LEON J. COLE

MADISON, WIS.,
April 19, 1911

REFORMED CALENDAR

A calendar project which ignores the immutable character of the week has slight chances of being adopted because the week is fixed by religious observance in all christian nations. The calendar here proposed is based on the week as a fundamental unit. It is closely similar to the calendar recently proposed by Dr. C. G. Hopkins, but differs in that it consists of a year of thirteen months, each four weeks in length, instead of Dr. Hopkins's twelve months divided into quarters of three months, each quarter containing two four-week months and one five-week month. Dr. Hopkins's reason for retaining twelve months is that the quarters of the year may be even months, but the value of the quarter year as a unit of time is incomparably less than the value of the month. It is highly desirable to have all the months the same length for the reason that salaries, wages, rent, board and many other ordinary affairs are counted in months. The advantage to be gained by having months of uniform length is one of the most marked advantages to be gained by a reform of the calendar.

In the present project the new month is inserted between June and July. This is the month in which the summer solstice occurs in the northern hemisphere and the winter solstice in the southern hemisphere, hence it may properly be called " Sol "—the month of the solstice.

In the new calendar the quarters are easily found, as each consists of thirteen weeks. The four quarters would end on the following dates: first quarter, April 7; second quarter, Sol 14; third quarter, September 21; fourth quarter, December 28; and these dates would all be Sunday in the new calendar. The present project therefore contains all the advantages of Dr. Hopkins's project, and the additional advantage of having all the months the same length, as well as multiples of the week.

Other advantages of the new calendar are: the year always begins on Monday; every month begins on Monday; the same day of the year always occurs on the same day of the week; the same is true of the days of the month. Thus, the first, eighth, fifteenth and twenty-second of every month would fall on Monday; the seventh, fourteenth, twenty-first and twenty-eighth of every month would fall on Sunday.

If desired Sunday may as well be taken as the initial day of the week, month and year.

An additional advantage is that a calendar for one year is good for all future time, as the years are all alike in all respects except that every fifth year has an extra week added to December, with exceptions noted below.

The details of the project are as follows:

Common years consist of thirteen months of four weeks each, namely, January, February, March, April, May, June, Sol (the month of the solstice), July, August, September, October, November and December;

Long years differ from common years in having an extra week added to December;

Years divisible by five are long years, with the exceptions noted below:

The extra week is omitted from years divisible by 50. It is also omitted in the year '25 following centennial years divisible by 400, and in the year '75 following centennial years divisible by 25,000. This makes a calendar good for more than 300,000 years.

In order to cause less confusion, this calendar should be adopted in a year that begins on Monday. In the near future these years are 1912, 1917 and 1923.

In order to secure the adoption of a reformed calendar, we must secure the appointment of an international commission with representatives from all civilized nations. It seems to me that our present duty is to begin a serious attempt to secure the appointment of such a commission. Can we not form an organization for this purpose?

W. J. Spillman

Washington, D. C.

QUOTATIONS

THE SCIENCE MUSEUM AND THE NATURAL HISTORY MUSEUM

During the past few weeks we have printed letters from several distinguished correspon-

dents dealing, from various points of view, with the very serious question that has arisen between the Office of Works and the trustees of the Natural History Museum concerning the respective claims of that museum and of the adjacent Science Museum to what remains still unoccupied of the space which separates the one from the other. No one can think that the buildings in which the Science Museum is at present housed are worthy of the dignity of science, or of their position as associated with the central home of science in the capital of a great empire. Every one should approve, therefore, of the recent appointment of a committee by the president of the board of education to consider the demolition of existing buildings and the construction of a new Science Museum on a scale worthy of its purpose and character. But it would appear from the recently published official correspondence between the Office of Works and the trustees of the Natural History Museum that this committee is only empowered to consider the construction of an enlarged Science Museum on the site now occupied by the unworthy and unsightly buildings which now go by that name. It is clear, however, that this can not be done—for on this point, at any rate, the Office of Works and the trustees are in full agreement—without encroaching on the space required for future enlargements, already urgently needed, of the Natural History Museum, and in fact on space which after much correspondence between the trustees, the Office of Works, and the Treasury, was formally allotted in 1899 to the Natural History Museum for that purpose. In the interest of the new Science Museum the Office of Works now proposes to resume possession of a strip some seventy feet wide and some 1,200 feet long, running the whole length of the north side of the area hitherto allotted to the Natural History Museum. This strip is at present occupied as to some portion of its length by a Spirit Museum—that is, a building for the storage and exhibition of specimens preserved in spirit, 145,000 in number, contained in 95,000 jars, many of large size—which has been erected and fitted up within recent years at a total cost of no less than £38,000. It is now proposed that, as soon as the Spirit Museum has been removed to a new and very objectionable site, a portion of this strip some forty feet wide should be assigned to the new Science Museum, while the remainder, some thirty feet wide, is to be converted into a private road separating the two museums.

It should surprise no one that the trustees should, as they say, view these proposals "with extreme apprehension." The only wonder is, perhaps, that the Office of Works should ever have entertained them seriously. It was originally proposed that the total area to be assigned to the Natural History Museum should be about fifteen and a half acres, and the steady growth of the museum in recent years has shown that this was not a yard too much. By the arrangement of 1899, to which we have already referred, this area was reduced to a little over thirteen acres, and it is now proposed to reduce it by very nearly two acres more, although, as the trustees point out, the reduced area of 1899 was accepted on the understanding that it was their intention to use the land in question for the further extension of the Spirit Museum, and "it can only have been by reason of such understanding that the trustees felt justified in accepting that line of boundary as a final settlement of the question." Yet if the Office of Works is to have its way, that final settlement is now to be treated as no settlement at all. The northern boundary is to be set back by seventy feet; the Spirit Museum is to be abolished and reerected facing Queen's Gate in such a position on the vacant space still surrounding the Natural History Museum as grievously to impair the symmetry and sightliness of any future extension of the latter; and the Science Museum and the Natural History Museum are to be left and even encouraged to approach each other from the north and south respectively in such a manner as may and probably will leave in the end only a private road some thirty feet wide between them. We can hardly believe that parliament and public opinion will ever sanc-

tion these extraordinary and most objectionable proposals. To judge from the correspondence which we have printed on the subject, they appear to find favor with no one—for even Sir Henry Roscoe could only find something to say for them by making a suggestion for the removal of the Spirit Museum to a distant site which other equally high authorities have shown to be inadmissible—and they have elicited protests of unanswerable cogency from naturalists of such high authority as the master of Christ's and Dr. Gilbert Bourne, as well as from the Linnean Society, the Entomological Society, and the Royal Horticultural Society. Moreover, the emphatic protests on other grounds and from other points of view of Lord Wemyss and of Lord Dufferin and those associated with him are by no means to be overlooked.

The plain truth is that, as the trustees put it in their final letter to the Office of Works, "to attempt to accommodate three important institutions, the Natural History Museum, the Imperial College of Science, and a much enlarged Science Museum, on so restricted a site shows a want of appreciation of the inevitable future of these institutions which is bound to lead to confusion and a waste of public money. Not only the Natural History Museum, but all three institutions, would soon be hampered in their growth." The propositions here advanced scarcely admit of dispute. The trustees point out that they have recently been enabled by the government to purchase land at Bloomsbury sufficient to provide for the extension of the departments located there in such a manner as to satisfy prospective needs of those departments for 100 years to come. Yet all that the Office of Works can say on behalf of its unhappy scheme for extending the Science Museum at the expense of the Natural History Museum is that "the vacant space to the east and west of the Natural History Museum is so great that it is hardly possible to suppose it will not afford abundant facilities for any extension of the Natural History Museum which may be required for the next twenty-five years"—which is just a quarter of the period for which the government have empowered the trustees to make provision at Bloomsbury. The comment of the trustees on this significant contrast appears to us to be quite unanswerable. They "feel bound to protest against the reversal at South Kensington of a policy so carefully considered and so universally endorsed"—as regards the departments at Bloomsbury, that is—"and they can not therefore, with due regard to their responsibilities, consent to give up land which will be urgently required in the near future for the extension of the Natural History Museum." To this most reasonable *non possumus*—reasonable because based on indisputable facts as well as on the authority of all competent experts—the Office of Works could only reply by a departmental *hoc volo, sic jubeo,* backed by the authority of the government. "The question of the revision of the boundaries has been considered by his majesty's ministers, and they have decided that such a revision can not be avoided in view of the pressing necessity for the building of a Science Museum." So far as we are aware no one disputes the pressing necessity for the building of a Science Museum. But surely no one who has studied the official correspondence or who has followed the discussion in our columns can defend or approve the policy of building such a museum at South Kensington in such a manner as must fatally hamper its own expansion and that of the Natural History Museum in the near future. There is manifestly no room for all three institutions on the same site. Two of them are there already, therefore the third must go elsewhere. That is the only rational solution of the problem, and it certainly ought not to be rejected by the mere fiat of his majesty's ministers without giving parliament and public opinion an opportunity of pronouncing judgment on the matter.—London *Times.*

SCIENTIFIC BOOKS

The Principles and Methods of Geometrical Optics. By James P. C. Southall. 8vo. Pp. xxiii + 626. New York. The Macmillan Company. $5.50 net.

Professor Southall, in his book on geometrical optics, undertook to put in one volume most of that which is valuable on the subject, especially as applied to optical instruments. He was filled with enthusiasm, inspired by a sincere belief in the value of the subject and an ambition to supply the admitted deficiency in the English language.

> Partly with the object of supplying this deficiency, and partly also in the hope (if I may venture to express it) of rekindling among English-speaking nations interest in a study not only abundantly worthy for its own sake and undeservedly neglected, but still capable, under good cultivation, of yielding results of far-reaching importance in nearly every field of scientific research, I have prepared the following work. . . .

It is such enthusiasm as this that holds one to the severe labor of preparing a large book and of making it a good book. While it is doubtful whether any large number of scientific men will follow Professor Southall in his very high estimate regarding the relative value of geometrical optics and in his optimism respecting its future, the careful and exhaustive book which he has prepared will undoubtedly do much to bring the geometrical theory of optical instruments into greater favor in this country.

Professor Southall treats in successive chapters the fundamental properties of geometrical optics, the properties of rays of light, reflection and refraction at a plane surface, refraction through prisms, reflection and refraction of paraxial rays at a spherical surface, refraction of paraxial rays through thin lenses, the theory of optical imagery, lenses and lens systems, exact trigonometrical formulæ for tracing rays through spherical surfaces and centered systems of spherical surfaces, theory of an infinitely narrow bundle through an optical system, theory of spherical aberrations including Seidel's theory developed to aberrations of the third order, color-phenomena and chromatic aberrations, aperture, and field of view and brightness of images. It is seen from this how extensive is the subject-matter treated. In general, all the chief discussions of the more important topics have been given. This has led to a duplication in very many instances; particularly, many subjects are treated both geometrically and analytically. This, of course, is not to be regarded as a positive fault in an exhaustive treatise, for the one method will appeal to some and the other method to others. But probably many will wish, on reading the book, that especially the first part had been written more concisely and with fewer repetitions of subject-matter under different forms. This would not be, however, in harmony with the obvious plan of reproducing essentially all that is of value in the subject. The alternate plan is to adopt a definite point of view and to develop the subject systematically from that point of view.

Probably the greatest service rendered by Professor Southall has been in setting forth clearly and consecutively the splendid optical theories of the German writers of the last half century, particularly those of Seidel and Abbe. His book may inspire us to divide with the Germans the future developments in these lines. At any rate all who have an interest in the subject will thank him that he has so well done his part, for it will not be questioned that he has prepared the best and most exhaustive work on geometrical optics in the English language. So far as the question of completeness is concerned there seems room for regret, and that mostly on the part of practical opticians, only in that the theories are not illustrated more by numerical examples based on the glasses of commerce.

F. R. MOULTON

A Laboratory Manual of Inorganic Chemistry. By EUGENE C. BINGHAM, Ph.D. (Johns Hopkins), Professor of Chemistry, Richmond College, Richmond, Va., and GEORGE F. WHITE, Ph.D. (Johns Hopkins), Associate Professor of Chemistry, Richmond College, Richmond, Va. New York, John Wiley & Sons; London, Chapman and Hall, Limited. 1911. 12mo, pp. viii + 147. Cloth, $1.00 net (4s. 6d. net).

In the preface the authors state that, in their opinion, "a course in inorganic prepara-

tions and systematic qualitative analysis, with a few carefully chosen quantitative experiments afford the best background for the theoretical development of the science." They have, in order to avoid superficiality, cut the number of experiments down to a minimum, necessary for the understanding of the subject in its elementary phases. They have given more experiments than can be done in the normal year's work in school or college, hoping to stimulate the ambitious student to further work.

They have selected 33 typical experiments which includes the preparation of the common gases and acids and the preparation of several salts. This is followed by a study of the typical reactions of the metals and a course in qualitative analysis. The book also contains a few pages devoted to the quantitative proof of some of the fundamental laws upon which the science of chemistry is based. The material given is well selected and clearly stated, though, as the authors state in the preface, they have introduced little that is new. The question that each teacher must solve is whether it is better to cover a limited field thoroughly or to cover a broad field by selected examples. If a student's knowledge of chemistry is to be gained by one year's work this book could be used no doubt to advantage in connection with a text-book and a course of lectures; but if the subject is to be pursued further each one of the separate fields covered here would have to be gone over again in greater detail in order to attain a suitable ground for more advanced work.

J. E. G.

A Naturalist in the Bahamas. By John I. Northrop. October 12, 1861–June 25, 1891. A memorial volume edited with a biographical introduction by Henry Fairfield Osborn. New York, The Macmillan Co. $2.50.

The present volume brings together the papers of the late Dr. John I. Northrop, describing the zoological, botanical and geological results of his six months' collecting on the Bahama Islands. It includes also a narrative of the expedition contributed by Mrs. Northrop; a report upon the Bahaman crustaceans by Professor William H. Rankin; on the actinians, by Professor J. Playfair McMurrich; on the shells by Professor William H. Dall; on plants by Mrs. Northrop, Mr. Frank S. Collins and Dr. O. F. Cook; and a paper describing the new oriole *Icterus northropi*, by Dr. J. A. Allen. All of these papers are carefully republished and the volume forms altogether a substantial contribution to American zoological literature. . . . One closes the book with the feeling of keen regret that the life of Dr. Northrop could not have been spared. If his early promise brought together both from his own pen and from those of his associates the present results, what may not his years of maturity have contributed? He was another Lycidas and zoologists will remember him with such men as Harrington, Budgett and Balfour.

Bashford Dean

THREE FORMICID NAMES WHICH HAVE BEEN OVERLOOKED

Mr. S. A. Rohwer has kindly called my attention to two generic names which have been overlooked by all recent myrmecologists, including Dalla Torre, the author of the "Catalogus Hymenopterorum." One of these names is *Typhlomyrmex*, which was given by Gistel in 1856[1] to *Myrmica typhlops* Lund. On referring to Lund's paper[2] I find that *M. typhlops* is mentioned without a description, and since the insect is certainly not a *Myrmica* in the modern sense and can not be identified from the few notes on its habits (moving in files and carrying isopods), the name must be regarded as a *nomen nudum* and hence without any standing in nomenclature. And since Gistel cites no characters for his genus *Typhlomyrmex* but merely bases it on an invalid name, it, too, is without standing. Mayr, without knowing of Gistel's work, described in 1862 a genus *Typhlomyrmex* for a neotropical ant, *T. rogenhoferi*

[1] "Mysterien der europäischen Insectenwelt."

[2] "Lettre sur les Habitudes de Quelques Fourmis du Brésil, addressée a M. Audouin," *Ann. Sci. Nat.*, XXIII., 1831, p. 113–138.

Mayr. A few other species have since been added. It is clear that *Typhlomyrmex* Mayr is valid and not to be replaced by some other name on account of Gistel's *Typhlomyrmex*, which has not even the status of a synonym.

More serious is the second case which involves *Polyrhachis*, an important genus comprising some 300 known species of paleotropical ants. The name *Polyrhachis* was first suggested by Shuckard in a volume which he published with Swainson in 1840.[3] On page 172 of this work occurs the following sentence: "It is in the first division that we find the stingless genera, namely, *Formica* Linn., *Formicina* Shkd., *Polyergus* Latr., *Polyrhachis* Shkd. and *Dolichoderus* Lund, besides several other yet uncharacterized genera which we shall shortly publish." As Shuckard did not live to give a description of *Polyrhachis* and cites no species as belonging to it, the name is merely a *nomen nudum.* It was, however, either resuscitated or reinvented in 1858 by Frederick Smith.[4] He described some twenty species of *Polyrhachis*, with Drury's *Formica bihamata* as the designated type. In the same year 1858 Gerstäcker[5] based a genus *Hoplomyrmus* on an African ant, *H. schistaceus* Gerst., which is clearly congeneric with the forms included by Smith in *Polyrhachis*. As Emery has shown,[6] there is some doubt as to which generic name was first published. Since Smith's paper was read before the Linnean Society in June, 1857, while Gerstäcker's was not read before the Berlin Academy till April, 1858, the genus *Polyrhachis* has been given precedence by subsequent writers. Emery has, however, adopted *Hoplomyrmus* as a subgeneric name for a number of species which he groups together as the cohort "Polyrhachides carinatæ."

[3] "On the History and Natural Arrangement of Insects," London.

[4] "Catalogue of the Hymenopterous Insects Collected at Sarawak, Borneo; Mount Ophir, Malacca; and at Singapore by A. R. Wallace," *Journ. Proc. Linn. Soc. Zool.*, II., 1858, pp. 42–130, 2 pls.

[5] *Monatschr. Akad. Wiss. Berlin*, 1858, p. 262.

[6] "Saggio di un Catalogo Sistematico dei Generi Camponotus, Polyrhachis e Affini," *Mem. R. Accad. Sci. Ist. Bologna*, 1896, p. 776 *nota.*

Speculation on the validity of *Polyrhachis* and *Hoplomyrmus* loses all its significance in the light of Mr. Rohwer's discovery that Billberg in his "Enumeratio Insectorum" published in 1820, a work of which there seem to be only two copies in America, one in the Museum of Comparative Zoology, the other in the library of the Boston Society of Natural History, had many years previously established the genus under another name. In this work on p. 104 we find the following:

"G. MYRMA Eg.—Formica ol.
Carinata N. Chaled. Fbr. | Hystrix Eg. 2"
militaris Afr. Aequin. — |

The "Eg." in this citation stands for "Billberg." It is clear that this author cites the two valid Fabrician species *Formica carinata* and *militaris* as representatives of a new genus *Myrma* for what was formerly a portion of the genus *Formica* Linn. Both of these species have long been regarded as *bonâ fide* members of the genus *Polyrhachis*, which, as has just been shown, was not established till 1858. The *hystrix* cited by Billberg is a *nomen nudum*, if it be not the *Formica hystrix* of Latreille and Fabricius, which is in turn a synonym of *Atta* (*Acromyrmex*) *octospinosa* Reich. The "Eg." after the name would seem to preclude this latter supposition. Be this as it may, however, there can be no doubt concerning the two other species, one of which, *F. militaris*, may properly be regarded as the type of the genus *Myrma*. This case seems, therefore, to be quite clear and to require, in obedience to our code of zoological nomenclature, the substitution of *Myrma* for *Polyrhachis*. Although this is a deplorable change, owing to the large number of citations of ants under Smith's generic name, there is, nevertheless, a slight gain in brevity and euphony. I would suggest, however, that *Polyrhachis* Smith be retained as a subgeneric name for the type *P. bihamata* Drury and the small cohort of allied species (*bellicosa* F. Smith, *ypsilon* Emery, *craddocki* Bingham and *lamellidens* F. Smith) which Emery calls Polyrhachides hamatæ. The typical subgenus *Myrma* will replace *Hoplomyrmus*,

since its type, *M. militaris*, is closely related to Gerstäcker's *schistacea*.[7] The species of *Myrma* may then be grouped under several subgenera, names for two of which are here suggested for the first time, as follows:

Genus Myrma Billberg (1820) = *Polyrhachis* F. Smith (1858).

1. Subgenus: *Campomyrma* subgen. nov.
   = Cohors Polyrhachides camponotiformes Emery.
   Type: *Polyrhachis clypeata* Mayr.
2. Subgenus: *Myrma* Billberg = *Hoplomyrmus* Gerst.
   = Cohors Polyrhachides carinatæ Emery.
   Type: *Formica militaris* Fabr.
3. Subgenus: *Polyrhachis* F. Smith.
   = Cohors Polyrhachides hamatæ Emery.
   Type: *Formica bihamata* Drury.
4. Subgenus: *Hagiomyrma* subgen. nov.
   = Cohors Polyrhachides arciferæ Emery.
   Type: *Formica ammon* Fabr.
5. Subgenus: *Hemioptica* Roger.
   Type: *Hemioptica scissa* Roger.

A third generic name, *Formicina* Shkd., which has been overlooked, is mentioned in the foregoing citation from the work of Swainson and Shuckard. This citation and the context seem to show that Shuckard accepted *Formica* Linn. in a restricted sense as the equivalent of what we now know as *Camponotus* Mayr., probably with the type *Formica herculeana* Linn., but this is open to doubt since no species is cited. On the same page two well-known ants are mentioned as species of *Formicina*, viz., *F. rufa* Linn. and *F. flava* Fabr. If only the former species had been mentioned, we might have been compelled to change our modern genus *Formica* to *Formicina*, but as Shuckard included also *F. flava* (which is at present *Lasius flavus*) in the same genus, we see that *Formicina* is merely a synonym of *Formica* as used by Fabricius and his contemporaries, possibly *minus* the group now known as *Camponotus*. Under the circumstances I can see no reason to replace any of the modern subdivisions of the old Linnean genus *Formica* with *Formicina* Shuckard.

W. M. Wheeler

[7] According to Emery *schistacea* is merely a subspecies of *militaris*.

ON MUSCOID AND ESPECIALLY TACHINID SYNONYMY

The time seems ripe for a few remarks on this subject. There exists in the superfamily Muscoidea an immense taxonomic field awaiting exploitation, and it is to be hoped that it will attract many able workers imbued with a proper sense of responsibility, for it is at the same time a biologic field of first importance and magnitude as regards arthropod and general invertebrate evolution. Only one caution is necessary to those who would enter this field, as well as to those already in it—and this applies as well to all workers in whatever field—which is to do one's work so thoroughly as to secure absolute finality before drawing positive conclusions. In other words, do not make an unqualified statement before going to the bottom of the matter in hand. Results secured during the past three years have demonstrated conclusively that finality in the taxonomy, and consequently in the synonymy, can not be secured in this superfamily by the off-hand comparison, or even by the most careful study, of external adult characters alone.

Mr. D. W. Coquillett, in his "Revision of the Tachinidæ of America north of Mexico,"[1] without the knowledge just mentioned and thus without any true conception of the great difficulties before him, moreover without a good eye for external characters and with little appreciation of their importance, but nevertheless with the best of intentions, attempted to group these flies comprehensively and indicated extensive but often incorrect synonymy, lumping even distinct genera under one species in the most uncouth but seemingly plausible manner. We can not but admire the industry and ingenuity which have contributed to produce this work, while we deplore its great lack of quality. Dr. J. M. Aldrich, in his "Catalogue of the North American Diptera,"[2] also without the above knowledge but with a somewhat better eye for external characters, though following Mr. Coquillett quite faithfully in the main, has resurrected a few

[1] Techn. Ser. Bull. No. 7, Div. Ent., U. S. Dept. Agr., 1897.

[2] "Smiths. Misc. Colls.," No. 1444, 1905.

species from the latter's synonymy. My own publications on the subject, which have been quite extensive and in which I have proposed many new genera and species, no small part of which may quite possibly have to go in the final synonymy, were produced almost in whole without the above knowledge but with a very considerable appreciation of the necessity for a most careful and minute comparison of external characters. Brauer and von Bergenstamm's monumental work, performed under the same conditions, and unquestionably the best and most advanced of all, must be classed here too, along with all other taxonomic work in the Muscoidea to 1908. The results in all these cases have been quite unfortunate, considering the amount of time and energy expended. All the material handled by Mr. Coquillett will have to be restudied with great care in the light of dissections of fresh material from type localities. My own types and those of Brauer and von Bergenstamm will have to be restudied in the same manner. In fact, all accessible muscoid types the world over will have to be restudied in this new light. Here is an amount of work to be done that almost staggers one to contemplate.

Brauer and von Bergenstamm possessed a most acute appreciation of the necessity for searching out even the most minute external characters in order to arrive at the true relationships of the forms. They probably carried the study of the external adult characters about as far as it can be advantageously done without correlation with the reproductive and early-stage characters. I have perhaps gone somewhat farther in my consideration of the external adult characters in the "Taxonomy of the Muscoidean Flies,"[8] but so far as I yet know without any great improvement in the general results. It is thus evident that, for the future, the older order of taxonomic work in these groups must be exchanged for the newer one, which has come into full light but recently, and which demands the exhaustive study not only of the external and largely the internal characters of the adult, but also of the characters of the eggs and early stages. It may even greatly profit by a study of general bionomics, especially host relations.

[8] "Smiths. Misc. Colls.," No. 1803, May, 1908.

It is truly a most remarkable state of affairs that finds us at the present day unable to define some of the most common genera of tachinid flies. Nevertheless, such is the fact and necessarily follows from what has here been said. The type species of each genus must be dissected before we may know what species, themselves dissected, can be referred to that genus. The material for such dissections should be fresh, and that for type dissections should be obtained from the type localities so far as possible. I have already done this work for a considerable number of genera, and the results will, I hope, be published within the year accompanied by necessary drawings. But hundreds of genera, many of them represented by names long in common use, remain to be investigated in this manner, and thus we frequently find ourselves at this late day unable to determine material in these groups with any hope of finality.

In a recent letter to me, Dr. John B. Smith has restated the conditions in the following apt words, which I can not refrain from quoting:

> It is perhaps not surprising that in the Diptera, which are without any doubt physiologically the most highly developed of all orders, the difficulties in classification should be greatest. Their specialization has extended in so many directions that the divergencies have become marked by internal modifications rather than external adaptations.

He precedes these remarks by stating his belief "that it will require a study of the internal organs to get a satisfactory classification, which may afterwards be helped out by external characters whose importance is not recognized at the present time." This remark is well worthy of consideration. The correlation of the external adult characters with those of the reproductive system and early stages will define the relative taxonomic value of the first in the various groups, and may reveal unsuspected characters among them which will hold good for considerable series of groups.

The publication at this time of these remarks in their present form has been prompted by the recent appearance of Mr. W. R. Thompson's "Synonymical and other Notes on Diptera,"[4] which have just reached me and which I am extremely glad in this case to see published, since they are here serving the useful purpose of calling forth some timely observations that would otherwise have been reserved for the future. It is hardly possible that the synonymy indicated in the above-mentioned notes will eventually prove to be final. If so it will indicate the possession on the part of its author of most astute perception and perfect judgment of external adult characters, such as I myself can not lay claim to after more than twenty years' study of these flies. For the present, it certainly can not be accepted as such. No matter how carefully done or how clear one's perception, final synonymy in these groups can not be attained by the mere comparison of external anatomical parts in museum material, types or otherwise. It will henceforth be simply a waste of time, energy, paper and ink to put forth such results without correlation with the other characters mentioned, and I will therefore not discuss here the merits of the points raised in these notes, of most of which I have very serious doubt. But I shall return to these points as soon as I can secure proper material for the necessary dissections.

If students wish to further the interests and advance the status of muscoid taxonomy, let them collect, rear and dissect long series of specimens from the type localities concerned; they will then be in a position to deduce final synonymical conclusions. Any other course in the present stage of progress of the work will only further obscure the subject. The same ground will all have to be covered again and all raised or unraised points thoroughly probed to the bottom. In the study of these flies, no matter who agrees as to synonymy, whether generic or specific, if they have not done their work exhaustively their agreement is of slight interest to the matter in hand.

[4] *Psyche*, October, 1910.

The statement that I am going to make now will probably astonish some people, but I can truthfully say that I would be greatly pleased to see half the generic and specific names that have been proposed in the Muscoidea safely relegated to the synonymy where they could rest undisturbed and buried forever, with no hope of a resurrection, a goodly sprinkling of my own among the number; but such a considerable reduction of names is hardly possible of realization. Looking toward a consummation of final synonymy, however, I shall hope to accomplish in the next few years some portion of the work necessary to this end, during the course of which I here pledge my word that those generic and specific names of my own making will receive the same impartial treatment at my hands as all others. My one wish in this matter is to secure certainty before putting a name into the synonymy. The making of incorrect synonymy is a much more serious taxonomic offense than proposing further names for forms already named. In the latter case the forms can always be definitely referred to by means of the names that have been bestowed upon them, but in the former case serious confusion is certain to ensue.

The main interest here, as elsewhere in biology, centers in the relationships, phylogeny, bionomics and kindred aspects of the forms, and this knowledge must point the way to a sound taxonomy. In many groups of organisms this knowledge largely follows a fairly stable system of classification, but here it must precede it. It only remains to impress repeatedly upon the student the extreme difficulty at best of rightly interpreting the characters in such a multitude of forms, many of which are closely similar in the adult; the at least present impossibility in many cases of separating these forms on external adult characters alone; and therefore the absolute necessity for making an exhaustive study with reference to all taxonomically utilitarian characters, external and internal, of all stages.

Let no one think that I have over-estimated the needs of this subject in the foregoing remarks. I further wish to say, in conclusion,

that without doubt all biologists, myself included, will take great pleasure and satisfaction in welcoming to this field all careful workers, whose services should be much appreciated where there is such a vast amount of labor waiting to be performed.

CHARLES H. T. TOWNSEND

PIURA, PERÚ,
January 29, 1911

SPECIAL ARTICLES

METAMORPHOSIS WITHOUT PARASITISM IN THE UNIONIDÆ

It has been known for a long time that in the genus *Strophitus* Rafinesque the embryos and glochidia are embedded in short cylindrical cords which are composed of a semi-translucent gelatinous substance, and that these cords, which are closely packed together, like chalk crayons in a box, lie transversely in the water-tubes of the marsupium. The blunt ends of the cords are seen through the thin lamella of the outer gill, which in this genus, as in *Anodonta* and others, constitutes the marsupium. The position of the masses of embryos, while contained within the gill, is so unusual that Simpson in his "Synopsis of the Naiades" established a special group, the Diagenæ, for *Strophitus*—the only genus of the family in which this peculiarity exists. In other genera the embryos are conglutinated more or less closely to form flat plates or cylindrical masses, each one of which is contained in a separate water-tube and lies vertically in the marsupium.

So far as we are aware, Isaac Lea[1] was the first to observe this interesting arrangement which he described and figured, rather crudely to be sure, in *Strophitus undulatus* (*Anodonta undulata*). In several subsequent communications[2] he added further details and illustrations, and also mentioned the occurrence of the transversely placed cords, or "sacks" as he called them, in *S. edentulus*. He recorded the former species as being gravid from September until March, and described the extrusion of the cords from the female, as well as the remarkable emergence of the glochidia from the interior of the cords after the latter have been discharged. "The sacks were discharged into the water by the parent," he says, "from day to day, for about a month in the middle of winter. Eight or ten young were generally in each sack, but some were so short as only to have room for one or two. . . . Immediately when the sacks came out from between the valves of the parent, most of the young were seen to be attached by the dorsal margin to the outer portion of the sack, as if it were a placenta."

The essential points in these observations have since been verified by other investigators. Sterki,[3] following the suggestion of Lea, has called the cords, which differ strikingly from the conglutinated masses of *Unio* and other genera, "placentæ"—thus indicating that he considered them to have a nutritive function. He also described the extrusion of the glochidia, when placed in water, and their attachment to the cord "by a short byssus thread whose proximal end is attached to the soft parts of the young." He further states that the glochidia are enclosed in the placentæ when the latter are first discharged, and that after their extrusion they remain attached for some time.

Ortmann,[4] in a paper on the breeding seasons of the Unionidæ of Pennsylvania, says of *S. undulatus*, which he regards as identical with *edentulus:*

> I found this species gravid in the months of July, August, September, October; also in May. The latest date is May 22, 1908 (one out of eleven individuals). Among numerous specimens collected on May 14 and May 27, 1908, no gravid females were present, and during the month of June such were never found, although a good number of specimens were collected. The earliest date again is July 11. This gives an "interim" from the end of May to about the middle of July.

In a later paper Ortmann[5] states that the discharge of the cords, which he proposes to

[1] "Observations on the Genus *Unio*," Vol. II., 1838.

[2] *Ibid.*, Vols. VI., X., 1858, 1863.

[3] *Nautilus*, Vol. XII., 1898.

[4] *Ibid.*, Vol. XXII., 1909.

[5] *Ibid.*, Vol. XXIII., 1910.

call "placentulæ," is not through the lamellæ of the gills, as Simpson has maintained, but that it occurs in the usual manner through the suprabranchial chambers.

Strophitus edentulus is a rare species in all of the localities in which we have collected mussels, and we have obtained, until recently, only the following records of its breeding from individuals taken in the Mississippi River near La Crosse, Wis., during the summer of 1908:

Date	Number of Individuals	Stage of Gravidity
June 10	1	glochidia fully formed.
July 6	1	glochidia fully formed.
July 9	3	glochidia fully formed.
July 10	1	glochidia fully formed.
July 9	2	not gravid.
July 17	1	not gravid.
July 18	2	not gravid.
July 29	1	not gravid.
July 29	4	young embryos.
August 11	1	young embryos.
August 11	3	late embryos.

Since these records include the interim between the breeding seasons, they confirm the statement of Ortmann and others that *Strophitus edentulus* is one of the so-called "winter breeders," or those species which have the long period of gravidity. The interval between the seasons, however, as indicated in the above records, is seen to be a much shorter one than that observed by Ortmann.

After verifying the main observations of Lea and Sterki, so far as was possible at that season of the year, we examined the glochidia carefully with a view to determining whether their subsequent life-history would exhibit any peculiarities, as might be suspected from their relation to the cords. At that time we did not observe the normal discharge of the cords by the female; but we removed them from the marsupium, placed them in water, and, after the glochidia had emerged, employed various means to bring about their attachment to fish. None of these attempts, however, was successful, although the fish were left in small dishes containing many cords for as long a time as twelve hours. In the light of these results, which indicated the inability of this glochidium to attach itself to fish, and in view of the fact that the cords so evidently seemed to be a nutritive device, we felt it to be highly probable that in this species the metamorphosis would be found to occur in the absence of parasitism—a prediction which has been recently verified.

On February 6, 1911, a single female of *Strophitus edentulus*, which had been under observation in the laboratory since last November, was seen discharging its cords from the exhalent siphon. The discharge has continued to the present date, March 25, and during this time the cords have been thrown out in varying numbers from day to day. They measure from 2 to 10 mm. in length and about 1 mm. in diameter, although they become more or less swollen after lying in the water for a time. Each cord contains from 10 to 24 glochidia arranged in an irregular row. In many cases the glochidia emerge from the cords in a few minutes after the latter are discharged, and then usually remain attached by the thread in essentially the same manner as has been described by Lea and Sterki. The thread, which is apparently a modified larval thread, is continuous at its distal end with the egg-membrane, which generally remains embedded in the cord; so intimate, in fact, is the union between the two, that at times the membrane, adhering to the thread, is dragged out of the cord when the glochidium is extruded—in which case, of course, the glochidium becomes entirely detached from the cord.

All attempts to infect fish with these fully formed glochidia have again been unsuccessful, even when the exposure has been of long duration. Within a few days, the extruded glochidia die in spite of every effort to provide the most favorable conditions for their maintenance.

When the cords first began to be discharged, one of our students, Miss Daisy Young, happened to notice that not all of the larvæ were extruded, and that among those which remained in the cords some had lost the larval adductor muscle, possessed a protrusible foot, and showed other signs of having undergone the metamorphosis. Upon careful examina-

tion this was found to be true, and it was discovered that these young mussels—for such they undoubtedly are—are subsequently liberated by the disintegration of the cord after *having passed through the metamorphosis in the entire absence of a parasitic period.* We, therefore, have concluded that the emergence from the cords in the glochidial stage is premature—due possibly to some change which has taken place in the gelatinous substance surrounding them as a result of free contact with the water or to release from the pressure to which they are subjected while in the marsupium. It is perfectly evident that these glochidia neither become attached to fish nor undergo any further development; they have simply come out too soon and are lost.

The young mussels, on the other hand, which have developed inside the cords, when liberated by the disintegration of the latter or removed directly by teasing, are found to have reached as advanced a stage of development as is attained by any unionid at the time it leaves the fish. They closely resemble the young of *Anodonta* at the close of the parasitic period, and upon examination have been found to possess the following structures: the anterior and posterior adductor muscles; the ciliated foot; two gill buds on each side; a completely differentiated digestive tract, including mouth, œsophagus, stomach, intestine and anus; liver; the cerebral, pedal and visceral ganglia; otocysts; the rudiments of the kidneys, heart and pericardium; and also a slight growth of the permanent shell around the margin of the shell of the glochidium. The larval muscle has completely disappeared, although some of the mantle-cells of the glochidium, as well as the hooks of the shell, are still present. They crawl slowly on the bottom of the dish by the characteristic jerking movements of the foot, after the manner of the young of other species at a corresponding stage, although the valves of the shell gape more widely apart and the foot is shorter and less extensible. We have not succeeded as yet in keeping them alive for more than ten days, but it is difficult in the case of any species to maintain young mussels of this age under laboratory conditions.

Since these young mussels do not respond to the stimuli which cause glochidia to close the shell and all attempts to bring about their attachment to fish have failed, and, furthermore, since their behavior in creeping on the bottom is characteristic of post-parasitic life, it would seem clear that no subsequent parasitism is possible. The conclusion is, therefore, inevitable that we have here to do with a species which has no parasitism in its life-history, although the presence of hooks and other typical glochidial structures would indicate that it has originated from ancestors which possessed the parasitic stage like other fresh-water mussels. The cord is undoubtedly to be interpreted as a nutritive adaptation which arises in the marsupium during the early stages of gravidity, since the young embryos are at first contained in an unformed viscid matrix and the cords are a later product.

The whole history of this exceptional species warrants a more detailed study, and Miss Young is now engaged in such an investigation. When her work is completed, we hope that it may include the entire course of development, the method of formation of the cords, and the rearing of the young mussels during a much longer period than has thus far been possible.

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March 25, 1911

THE SCALES OF THE ALBULID FISHES

Albula has long been regarded with unusual interest by ichthyologists, being an isolated type standing near the base of the Teleostean series. It is exceptional among all teleosteans, Boulenger remarks, in having two transverse series of valves to the bulbus arteriosus instead of one; an approach to the condition of the "Ganoids," in which there are three. Gill admits the "Ganoids" into the teleostean series, and according to his arrangement *Amia* falls in the order Cycloganoidei, just before or below the Malacopterygii, of which *Albula* is a primitive member. In Smithsonian Misc. Coll., Vol. 56, No. 3, p. 2, I have

described the scales of *Albula*, showing that they have much in common with those of *Amia*, and are very different from those of *Elops*. The Albulidæ are evidently much nearer to the Cycloganoidei than are the Elopidæ, and if these two families stand side by side in the system, it must be understood that they are nevertheless quite far apart in fact. The striking feature of the scales in which *Albula* resembles *Amia* is the entirely longitudinal (instead of transverse) arrangement of the basal circuli, which in fact should be called *fibrillæ*. In *Amia* the nucleus is subapical, and the broad nuclear area is rugulose or covered with fine labyrinthiform markings. All this is seen in the living *Amia calva*, but even more beautifully in the Miocene *Amia scutata* Cope, scales of which I obtained at Florissant last month. Cope states that the scales of *A. scutata* are larger than those of *A. calva*, but I find them to be practically of the same size, with very strong longitudinal fibrillæ, fraying out basally, and a most beautiful and intricate labyrinthiform sculpture in the broad nuclear area. This labyrinthiform condition of the nuclear area is not uncommon among the lower groups of teleosteans in the stricter sense, and is variably developed in *Elops*. In the characinid *Prochilodus rubrotæniatus* Schomb. the transition from the rugose or labyrinthiform nuclear area to the regularly circulate type is curiously shown, the area becoming multinucleate, with several small "islands" surrounded by circuli. *Albula vulpes* has large subquadrate scales, with about three basal radii, leading to deep emarginations of the base, which therein departs markedly from *Amia* and resembles the normal condition of many higher Teleosts. The subapical region is rugulose, very much as in *Amia*, but the true nucleus, just below it, is surrounded by fine regular circuli. It is in this small central region, above the nucleus, that *Albula* has genuinely transverse (concentric) circuli. It is also to be remarked that the basal circuli are all beaded in *Albula*, whereby they differ from *Amia*, but agree with the Osteoglossidæ.

Strong new interest in the Albulidæ has been aroused by the description of a new genus by Mr. Henry W. Fowler in *Proc. Acad. Nat. Sci. Philadelphia*, LXII. (1911), p. 651. This very interesting fish, *Dixonina nemoptera*, was found mixed with specimens of *Albula* from Santo Domingo, collected long ago by Gabb. Fowler writes of the scales that they are "cycoid, inner edges mostly crimped, outer or exposed edges thin or membranous and ragged, marked submarginally with a concurrent vertical ridge or striation, the true edge of the scale." I am greatly indebted to Dr. D. S. Jordan for an opportunity to study a couple of scales of *Dixonina nemoptera*, taken from the original type. They are about 8.5 mm. broad and long, and in structure agree perfectly with those of *Albula*. The nucleus with its concentric circuli, the beaded longitudinal basal circuli, the three basal radii and three basal emarginations, etc., are all the same. The dermal pigment spots also agree. In some ways this exact correspondence is rather disappointing, but it shows the conservative nature of the scale-pattern, and rather emphasizes its value as diagnostic not merely of the genus *Albula*, but of the group to which it belongs.

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THE SIGNIFICANCE OF LEAD ARSENATE COMPOSITION

The control of a large class of the insect pests of growing crops depends on the use of arsenical sprays, and the commercial importance of such spraying has assumed very large proportions in recent years. Two factors determine the limits to which such methods may be carried with success. The first factor is the amount, character and timing of the applications necessary to control the insect. The second factor is the degree of toleration for the spraying treatments which the crop in question may possess. It is with the latter part of the problem that the following discussion is concerned.

Arsenic may injure plants quite as seriously as animal tissue, and the efforts of investigators have been directed towards preventing

the absorption of the arsenical by the sprayed plants. It is assumed that solid bodies can not penetrate the epidermis of healthy plants, but the absorption of liquids is known to take place. Nothing has developed to show that the first premise is unsound, and the question may well be asked, why have many of the arsenical compounds designated as insoluble by chemists, proved to be injurious when applied as sprays? The most obvious answer is found in the supposition that these compounds are not insoluble under the conditions of the application.

Solubility implies a solvent, and the most universally present solvent found in nature is water. Chemists base their estimates on solubility in pure water, and on the results of comparatively short exposures to this solvent. On the other hand, natural water may not be pure, and under some climatic conditions the exposure of spray deposits, on plants, to the action of natural water may be very prolonged.

It is very important to note that the last implied condition, that of prolonged exposure of the spray deposit to moisture, is one which prevails to a great extent in the Pajaro Valley, California. This valley is situated near the coast, about one hundred miles south of San Francisco, and opens out onto the ocean. The apple orchards of the locality have exhibited a remarkable susceptibility to arsenical injury, and to such an extent as to seriously interfere with effective control of the codling moth by the use of arsenic compounds. The industry is a large one, as the production has averaged over three thousand cars annually for the last ten years. An industry of such proportions was deserving of considerable attention from those delegated to foster the horticultural interests of the state, and the university experiment station has properly responded to the demand.

Field and laboratory work was commenced in the spring of 1903, and the author became connected with the investigation in the fall of that year. Since that date the work has gone on continuously, and largely under the writer's supervision.

That the results have been satisfactory, is reflected by the methods of spraying and materials used by the growers at the present time. The influence of this investigation is also apparent in the orchard practise of the entire Pacific coast and many of the interior states, but comparatively little publication has been done. Now that the attention of many investigators is being attracted to arsenical injury and kindred problems it appears that the results of our work should be properly published. With this end in view, the author has recently issued a circular entitled "Foliage Testing of Arsenicals." In the present article it is intended to cover in more detail the purely chemical considerations.

To continue with water solubility; the climatic conditions of the Pajaro Valley are peculiar in that there is a large amount of fog and dew moisture through the spring and summer months. The foliage of the trees becomes wet early in the evening and remains so during the night and well into the following morning. This condition may continue without interruption for a period of several weeks. The dew and fog moisture may at times be abundant enough to drip liberally from the trees, but more often it is nearly all retained on the foliage where it evaporates during the following forenoon. Such conditions are evidently ideal for dissolving substances on the leaves, and for the absorption of the solutions by the plant tissues. As contrasted with rains which wash dissolved substances entirely away, the above-described conditions are much more trying, and partly explain why apple foliage in the eastern states has been so little subject to arsenical injury.

With regard to the action of substances in solution in the water used to suspend arsenical compounds, when applied as a spray, Haywood and McDonnell[1] and others have shown that chlorides, carbonates and sulphates render the arsenic oxide in certain varieties of arsenate of lead more soluble and increase the danger of foliage injury. On the other hand, we have found that distilled water does not

[1] U. S. Dept. of Agr., Bureau of Chemistry, Bul. 131, p. 46.

eliminate the injury, but may prolong the time required for it to take place. Also, arsenicals of several types, applied as dust sprays (without water), have produced injury under our climatic conditions. At the same time and under the same conditions arsenicals have been applied that produced no injury or a very small amount. Such variation from perfect foliage neutrality to serious injury was found in a series of arsenate of lead samples. The samples which produced no injury were found to still retain their non-injurious properties when mixed up for spraying in any of the various waters in common use in the locality. These waters vary from 40 to 150 parts per 100,000 of salts in solution; chlorides, carbonates and sulphates forming the bulk of the salts.

Thus, all degrees of injury were obtained when samples of that material commonly known as arsenate of lead were applied to foliage with the same water. Such results indicated a radical difference in the chemical properties of the various samples. Chemical authorities mention several plumbic arsenates, but consider them as being alike insoluble in water. However, "Handbuch der Anorganischen Chemie" (O. Dammer), Vol. 11, Part 2, pp. 565 and 566, states that pyro-arsenate ($Pb_2As_2O_7$) is soluble in ammonia while the ortho-arsenate [$Pb_3(AsO_4)_2$] is not. This brief statement requires interpretation and may be expanded as follows:[2] The acid arsenates are stable under acid conditions, but are transposed into the ortho-arsenate, the most stable compound, under neutral and alkalin conditions. This transposition involves the liberation of arsenic oxide or soluble arsenates. The significance is at once apparent. When arsenate of lead is applied as a spray it is subjected to neutral and alkalin conditions. This is especially true if the water used in spraying contains alkalies. That is, the conditions favorable to transposition of the acid arsenates into the ortho-compound obtain. As fast as the neutral waters of fogs, dews and rains wash away the liberated arsenic oxide, or when the latter is absorbed by the plant tissues themselves, the conditions are restored for more to be formed. The ultimate result is the complete transposition of the acid arsenates to the ortho-compound and the liberation of the excess arsenic oxide.

At the time when these conclusions were reached we had the records of a large number of foliage tests with arsenate of lead samples. Checking these off showed that without exception those simple plumbic arsenates which produced no injury contained lead oxide and arsenic oxide in the correct proportions to produce the ortho-arsenate.

These results were obtained in 1906 and in the early part of 1907, and while the evidence was then sufficient to exclude practically all doubt, it was thought best to wait until several years of commercial spraying and supplementary experimental work should give incontestable grounds to announce the deductions as fully supported by experimental evidence.

To continue further with deductions which are probably correct. Some authors recognize pyro-arsenate ($Pb_2As_2O_7$) and others only hydrogen-arsenate ($PbHAsO_4$) as occurring in wet precipitates. Our results apparently show that both compounds may occur in commercial lead arsenate. Foliage tests show that pure hydrogen-arsenate behaves differently from mixtures containing considerable proportions of the ortho-arsenate. These mixtures of ortho and pyro are more rapidly injurious than the pure hydrogen-arsenate.

A chemical explanation of this fact is apparent. Lead-hydrogen-arsenate is $Pb_2As_2O_7$ to which one molecule of water has been added; that is, $Pb_2As_2O_7 + H_2O = (PbHAsO_4)_2$. In other words, $PbHAsO_4$ is a product of the hydrolysis of $Pb_2As_2O_7$. The H_2O may even be regarded as water of crystallization as the hydrogen-arsenate is crystalline rather than amorphous in structure. This rearrangement of the molecule gives opportunity for rapid transposition to the ortho-arsenate, and would

[2] The credit for this interpretation belongs to Mr. E. E. Luther, at that time (1906) an assistant in the laboratory at Watsonville. This discovery not only explained the injurious properties of certain types of lead arsenate, but also indicated the means by which such injury could be overcome.

explain the more rapid injury from samples containing unhydrolized pyro-arsenate.

The Ammonia Test.—The reaction between ammonia water and the acid arsenates of lead may be used to test the presence of these compounds in a sample.

A fair-sized sample (10 to 20 grams) is worked up in water (25 to 50 c.c.) and an equal volume of strong ammonia (26° B.) is added. This is digested with heat, agitated and finally brought to the boiling point. The sample is then allowed to cool and settle, and the clear solution decanted through a filter. The filtrate is boiled until the ammonia is nearly or all driven off. The remaining solution is then made distinctly acid with acetic acid, and a concentrated solution of lead acetate containing free acetic acid is added. Any arsenic acid which the filtrate may carry will then be precipitated in the form of acid arsenate of lead. With no precipitate forming at first, add the lead acetate solution to large excess and allow to stand. A preciptate may appear in a few minutes or an hour.

With this treatment pyro-arsenate, hydrogen-arsenate and mixtures of ortho and pyro give abundant white precipitates. In any case where the precipitate forms at once and can be designated as more than a trace, *i. e.*, renders the filtrate opaque, the sample will prove injurious under foliage test conditions, and will probably prove injurious in commercial spraying operations, especially where climatic conditions favor such injury. On the other hand, samples which show no ammonia test are practically free from foliage-injuring properties.

The ammonia reaction is complete and may be used for the quantitative determination of any arsenic oxide that may be present in excess of that required to form the ortho-compound.

Errors arising from Chemical Tests and Analysis.—It is not enough to know that the ratio of As_2O_5 to PbO is as 1 to 2.90 or more. The essential thing is whether all the PbO is combined with the As_2O_5. Chlorine and organic bodies may retain sufficient lead to materially affect the nature of the compound. In case the arsenic oxide content is slightly greater than it should be, and an estimable quantity of chlorine is present, the sample will certainly give an ammonia test and prove injurious to foliage under test conditions.

The true ortho samples will probably show an excess of lead oxide amounting to 1 to 4 per cent.

The ammonia test is positive except in rare cases where the uncombined lead is sufficient to take up the liberated arsenic oxide.

Water Solubility.—This subject has received much attention from chemists but as usually handled, does not indicate the true condition of the sample. Most arsenicals yield only a limited portion of their arsenic to a given amount of water, but may repeat this a very great number of times. As has already been shown, the liberation of arsenic oxide from the acid arsenates depends on transposition to ortho under neutral and alkalin conditions. However, the amount of arsenic acid taken up by a given volume of water can not exceed a very small quantity before the reaction of the solvent becomes acid and stops the transposition. As a matter of fact, such solutions are neutral or alkalin to litmus.

The water solubility of arsenate of lead is readily shown in a qualitative way by digesting in water for a time (ten to twenty-four hours), decanting through a filter, acidifying the filtrate with acetic acid and then adding lead acetate solution as in the ammonia test. A white precipitate or turbidity indicates water-soluble arsenic oxide. This operation should be repeated a number of times to determine whether the amount of dissolved arsenic oxide remains a constant. With this method of treatment ortho- and acid-arsenate samples show a decided difference in behavior. Both arsenates may show about the same arsenic oxide content per unit volume of water for the first two or three washings. After that, however, the quantity of arsenic removed from the ortho sample will be very much reduced, but that from the acid sample will remain practically constant for a large number of washings. A device by which a con-

stant stream of pure water could be run through the sample and collected for evaporation to a suitable volume would likely be the best method for determining relative water solubility.

Laboratory Preparation of Lead Ortho-arsenate.—Very few American chemists appear to have experimented with the ortho-arsenate of lead. Probably this is due to the fact that the formulas most often published do not produce this compound in the pure state, that is: unmixed with acid arsenates. True ortho-arsenate may be prepared as follows:

Solutions of lead acetate or nitrate and arsenic acid or ammonium, sodium or potassium arsenate containing the correct weights of the oxides (1 part of As_2O_5 to 2.90 PbO) are poured together. The water should be sufficient to dilute the precipitate so that it will not form too thick a mass. To this mixture ammonia is added to strong alkalinity. The mixture is digested with gentle heat for an hour or more, allowed to settle, and the clear liquid tested for arsenic oxide as described under the ammonia test. If a precipitate forms, a little more lead solution is added and the procedure repeated until no precipitate appears. It is well to wash the finished product and again treat with ammonia. If any arsenic oxide appears in the filtrate more lead solution should be added. Finally wash to the complete removal of water-soluble salts. In accordance with well-known principles of chemistry the retention of the arsenic oxide will not be complete until there is an excess of the precipitant, that is, lead oxide. For this reason true ortho samples will show less than the theoretical percentage of arsenic oxide (25.59 per cent.). With commercial samples, where allowance has to be made for impurities, this percentage is still further reduced.

It appears, then, that the federal insecticide and fungicide law rules out commercial ortho-arsenate of lead prepared on a 50-per-cent. water basis, by requiring 12.5 per cent. arsenic oxide. The manufacturers may still comply with the law by reducing the water percentage, but this is done at expense of easy remixing, so working a hardship on the consumer. It is my opinion that this clause in the act should be amended to read: "In the case of strictly ortho-arsenate of lead, the arsenic oxide content shall not be less than 11 per cent. or more than 12.5 per cent. on a 50-per-cent. water basis."

Further Discussion of Water.—Haywood, as already cited, has shown that chlorides, carbonates and sulphates may seriously increase arsenical injury from acid and pyro-ortho mixtures even when present in comparatively small amounts. Some recent results with these arsenates in commercial spraying apparently bear out such conclusions. The commercial ortho-arsenate usually contains enough excess lead oxide to offset these effects, but cases can be imagined where this compound might be partly decomposed. In such instances it is clearly possible to overcome the difficulty by treating the water with lead acetate. The addition of lead acetate until the water shows a reaction for soluble lead should give the desired result. The presence of small amounts of lead acetate will not prove injurious, and we have applied the carbonate and sulphate in very large quantities without producing the slightest injury. Lead acetate will completely overcome the effects of carbonates and sulphates and should greatly reduce the solvent action of chlorides.

Acknowledgments.—The investigations of which the features of this discussion form a part have had a wide scope and important contributions have been made by several people, among whom may be mentioned Professors C. W. Woodworth, W. T. Clarke, Geo. E. Colby and Mr. E. E. Luther.

W. H. VOLCK

WATSONVILLE, CAL.

SOCIETIES AND ACADEMIES

THE WASHINGTON ACADEMY OF SCIENCES

THE Washington Academy of Sciences held its 71st meeting in the auditorium of the New National Museum on the evening of April 18, 1911. President F. W. Clarke presided.

Sir John Murray, of Scotland, gave a most interesting and beautifully illustrated lecture on "The Ocean."

Maps were shown that gave the depths of the several oceans, the directions of their currents, their temperatures at all depths, their salinity, density and other physical conditions. The importance of each of these phenomena was clearly stated and their interdependence carefully explained. It was explained, for instance, that life at considerable depths in the sea is dependent upon vertical circulation, because in this way only is it possible to bring to the lower portions the necessary amount of oxygen. This explains the absence of life in the deeper portions of the Black Sea in which the distribution of density is such that it produces horizontal currents only.

Even those portions of the ocean farthest removed from land have an abundance of animal life, which in the last analysis must live upon vegetable matter. But this, the lecturer explained, is everywhere present in such abundance, though consisting of microscopic individuals, that the oceans may be thought of as vast meadows containing even more vegetable matter than is upon the land.

A most interesting and possibly important fact is the change, after a lapse of a few years, in the temperature of the deeper layers of the sargasso sea. These temperatures should be taken several times a year for a number of years, for the purpose of determining whether the change is cyclic, and what its causes and its consequences are.

These are only some of the topics discussed in a lecture that combined in the highest degree the interesting and the instructive.

THE 70th meeting of the Washington Academy of Sciences was held in the assembly room of the Cosmos Club at 8:15 P.M., March 30, 1911. President F. W. Clarke presided.

Professor Dr. Victor Goldschmidt, professor of mineralogy in the University of Heidelberg, Germany, presented a paper on "The Nature of Crystals."

The lecturer began with humorous descriptions of school-day experiences when we studied crystallography by the aid of painted wooden and pasteboard models, and from them got the idea that real crystals were mighty poor imitations of our beautiful wooden blocks.

By way of emphasizing the importance of the subject of crystallography it was stated that all ice and snow, all rocks whether of mountains or in the deep strata of plains, the moon, wandering meteors and all solids from liquids, are crystals.

A philosophical and all-comprehensive definition of crystals was then developed, and contrasted with the similar definition of a liquid. A crystal was defined as being: "A solid system of like particles with like orientation." A liquid was defined as "A system of gliding and rotating particles."

Any one who thinks crystallography either an unworthy or uninteresting subject is very much mistaken, Dr. Goldschmidt declared, and by his lecture, in the opinion of all who heard him, made good this claim.

W. J. HUMPHREYS,
Secretary

THE BOTANICAL SOCIETY OF WASHINGTON

THE 73d regular meeting of the society was held at the Cosmos Club, Tuesday, May 2, 1911, at eight o'clock P.M. President W. J. Spillman presided. Thirty-one members were present.

Mr. Walter T. Swingle presented a review of a recent paper by de Vries entitled "Ueber doppeltreziproke Bastarde von *Œnothera biennis* L. und *O. muricata* L.," in *Biologisches Centralblatt*, 31: 97–104, No. 4, February 15, 1911. This review will appear in full in SCIENCE.

The following papers were read:

The Recent Excursion into the Dismal Swamp: F. V. COVILLE.

After describing an excursion made by the Washington Academy of Sciences into the Dismal Swamp of Virginia, April 28–30, 1911, the author discussed the characteristic plant associations of the Dismal Swamp which are those of the "black gum" and the "juniper" areas, the latter being of unusual ecological interest.

The "juniper" lands of the Dismal Swamp have a special flora different from the other floras of the region. The characteristic tree is the southern white cedar (*Chamæcyparis thyoides*), locally known as "juniper." The common shrubs are swamp blueberry (*Vaccinium corymbosum*), white alder (*Clethra alnifolia*), inkberry (*Ilex glabra*), fetterbush (*Pieris nitida*), and various other species belonging to the heather family. The soil is a red-brown peat, made up of the dead roots, twigs and leaves of the swamp vegetation. The water of these juniper swamps contains a remarkably small quantity of mineral matter, and has the color of tea, due to a dilute solution of organic matter derived from the peat. When tested with phenolphthalein the water gives an acid reaction, to the degree of .0005 of a normal acid solution. The peculiar flora of the juniper swamp

is attributed to the acidity of this water and of the peat from which it flows, the chemical qualities of the water preventing the growth of the organisms of decay, and preserving the soil in such a condition of acidity as to make it impossible for ordinary swamp plants to grow on these lands. The "juniper" trees and other vegetation of these areas are specially resistant to acidity and are able to grow with luxuriance in such a situation. The antiseptic quality of this water is further attested by the estimation in which it has long been held among sailors for drinking purposes. Before the days of distilled sea water, the favorite water supply of ships leaving Norfolk on a long voyage was "juniper" water from the Dismal Swamp. No other water was so highly esteemed and none kept its sweetness so well.

The Effect of the Reaction of Solutions on the Growth of Wheat Seedlings: J. F. BREZEALE and J. A. LE CLERC. (Read by Dr. Le Clerc.)

The authors showed, by the use of lantern slides of photographs of seedlings grown in various solutions, that the development of the roots of the seedlings was injuriously affected by all the solutions that had become appreciably acid in reaction. This acid reaction was most marked with the application of KCl and K_2SO_4, the plant exerting a selective action for the K ion, thus leaving the acid radicle Cl or SO_4 behind, which in turn made the culture-medium acid by which the growth of the roots was stunted. The conclusion was drawn that the reaction of the solution played a most important rôle in the development of the seedlings.

Some Changes which take Place in Stored Grain: Dr. J. W. T. DUVEL.

This paper treated mainly of the more important changes which take place in commercial corn during storage in grain elevators and holds of steamships. Corn thus stored frequently contains relatively high percentages of moisture, thus affording an excellent opportunity for the development of molds and bacteria. The development of these organisms, together with the action of unorganized ferments, is accompanied by a distinct and rapid increase in temperature and a marked deterioration in the grain. Such grain is known commercially as "heating" or "hot" and after it starts to go "out of condition" it usually reaches a temperature of from 135° to 150° F. within a very few days. The viability is greatly reduced or entirely destroyed, and there is a marked increase in the acidity, a reduction in the percentage of both sucrose and invert sugar, and a considerable loss in fat. Other important changes also occur in the chemical composition of the grain, together with a heavy loss in weight and a lowering in the weight per bushel.

W. W. STOCKBERGER,
Corresponding Secretary

THE ASSOCIATION OF TEACHERS OF MATHEMATICS IN THE MIDDLE STATES AND MARYLAND

THE sixteenth meeting of the association was held in Teachers College, New York, April 22, 1911. The meeting was called to order by the president, Dr. Wm. H. Metzler, at 10:30 A.M. in the chapel of the college.

After the reading of the minutes, Mr. Breckenridge, chairman of the committee on continuation schools, reported the progress of his committee. The report was very interesting in the matter of the attitude of the students in those schools for more pure mathematics, merely because of their place in the curriculum of the ordinary day school. The report was accepted and the committee was continued. The algebra syllabus committee was also continued.

The first paper of the morning was given by J. S. Rorer, of the Wm. Penn High School, Philadelphia, on "The Curriculum: Present Tendencies, Future Possibilities."

The work of the morning was concluded by a paper by A. M. Curtis, of the Oneonta Normal School, on "Study Supervision: Its Needs in the Mathematics of the Elementary and Secondary Schools."

The first paper of the afternoon was a description, with lecture table models, of the slide rule and its uses, by Clifford B. Upton, of Teachers College. This was followed by a description, with stereopticon illustrations, of the calculating machines then on exhibition in the educational museum of Teachers College.

Preliminary reports for the committees on arithmetic, algebra and geometry were given by Mr. Rorer for the committee on arithmetic and by Mr. Durrell for the committee on geometry. These reports consisted of plans for carrying on the work.

After expressing its thanks to Teachers College the meeting adjourned to the educational museum for the privilege of inspecting the exhibition of slide rules, calculating machines, rare books and manuscripts.

H. F. HART,
Secretary